LOWER WALLAMBA RIVER RIVERCARE PLAN COMPANION BOOKLET

September 2003

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Preface

The preparation of the Lower Wallamba River, Rivercare Plan was funded by the:

- **Karuah Catchment Landcare Group with funds from the Natural Heritage Trust;**
- **Great Lakes Council; &**
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Acknowledgments

I would like to thank the landholders along the Wallamba River and other water user's for providing the opportunity to meet and experience this wonderful part of Australia. Their comments on the behaviour and characteristics of this waterway were invaluable. Thankyou also to Rick James & other DIPNR technical staff for relevant background information and technical support. Lastly, thankyou to Great Lakes Council, notably Gerard Tuckerman, for their efforts in sustainable natural resource management in the Wallis Lake Catchment.

River Plan Foreword

The Lower Wallamba River, Rivercare Plan has been produced to assist landholders with the restoration and management of the Lower Wallamba River for future generations.

The Rivercare Plan includes seven enlarged aerial photographs covering approximately twenty-seven (27) kilometres of river and surrounding land, and a Companion Booklet. Important information is collated and presented on these photographs, including infrastructure, stream information, areas of environmental or cultural significance and any stream problems. The management actions and strategies for the plan are presented in two forms.

1. Recommendations for on-ground works identified for each property are located on the aerial colour photograph enlargements. Most of these recommendations have been discussed with the relevant landholders during riverwalks. Copies of the aerial photographs are held with Great Lakes Council, and the Department of Infrastructure, Planning and Natural Resources, Taree office.

2. Broad river management strategies are communicated in a Companion Booklet. The booklet provides landholders with important information on river processes, broad river problems and the management options available. These options give an understanding of how typical stream problems can be prevented and rehabilitated.

The intent of the Rivercare Plan is to provide recommendations to address existing stream problems present along Wallamba River and provide landholders with information to make educated decisions regarding property management and stream health, with the objective of enhancing the rivers long term sustainability.

The plan is an important link between the community, local government and state authorities. All of these stakeholders have been involved in the preparation of the plan and hold some responsibility for the implementation phase.

General Rivercare Plan Management Issues and Recommendations

In the Lower Wallamba River Rivercare Plan area, the major issues identified were;

- River bank erosion;
- Stock damage to stream banks and riparian vegetation;
- Foreshore reserve management;
- Lack of a wide and diverse native riparian vegetative buffer;
- Water quality;
- Weeds;
- Acid sulphate soils;
- Log jams / snags; &
- Fish passage blockages.

The recommendations contained in the plan are both long and short-term goals for the management and/or control of the identified issues. These include;

1. Where appropriate, reduce the impact of stock on the riparian zone by fencing and providing alternative shade. Revegetate/encourage regeneration of eroded riverbanks with native indigenous trees, shrubs and grasses.

2. GLC to liase with Lands NSW to determine how best management practices can be implemented on foreshore reserves to improve and protect natural values of the river and Lake System. Consider the benefits of Crown Land swaps &/or conservation agreements that focus on implementing key findings of *Independent Inquiry into Coastal Lakes.*

3. Department of Lands and GLC to investigate to possibility of dedicating all foreshore reserves for environmental protection, as per Independent Inquiry into Coastal Lakes by the Healthy Rivers Commission, to secure the long term ecological health of the river and Lake System.

4. Waterways to develop a Boating Management Plan (BMP) for the entire Wallis Lake System that focuses on the protection of the Lakes unique values, as well as providing opportunities for all user groups. This BMP should include the introduction of a code of conduct that promotes best management boating principles; and the introduction of a licence scheme that sees skiers contributing directly to the rehabilitation of the waterway.

5. Assess the long-term viability of skiing activities on the Wallamba River, due to high numbers of user's, amount of breaches observed and the widespread impact on the river.

6. If skiing is the long-term usage option for river, carry out large-scale bank protection works in the reach from ARL 6km (end of Manns Road) to ARL 14km (River Inn), to rehabilitate eroded riverbanks.

7. Estuary committee to initiate a management initiative to improve fish passage on the Wallamba River, ie. Remove Clarkson's Crossing.

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1.0 Introduction

1.1 The Catchment

The Wallis Lake catchment is located on the mid north coast of NSW, approximately 250km north of Sydney. The catchment covers an area of 1440km^2 and is bounded by the Manning River and Khappinghat Creek catchments to the north and west, and by the Myall and Smith Lakes to the south.

Figure 1: Location map showing the extent of the lower Wallamba Rivercare River Plan.

Wallis Lake catchment is drained by the Wallamba, Coolongolook, Wallingat and Wang Wauk rivers which all converge at the northwestern end of the Lake, adjacent the island/entrance area of the estuary. The Wallamba River is the largest sub-catchment covering approximately 590km^2 or 41% of the catchment.

Wallis Lake is one of the largest coastal lagoons in New South Wales (85km^2). The lake is a significant natural resource that has a high diversity of both terrestrial and aquatic ecosystems. Wallis Lake is recognised as a wetland of national significance with extensive sea grass meadows, salt marshes and mangrove forests. The region supports a number of threatened species and provides habitat for a number of migratory bird species protected under international agreements (see appendix 8.8 & 8.9).

The natural resources in the Wallis catchment form the basis of agriculture, aquaculture (oyster), fishing and tourism industries. The health of these natural systems produces benefits, be it financial or cultural, for the whole community. Hence, the conservation and preservation of the lake is extremely important for both environmental and economic reasons. The importance of maintaining the health of the lake system is emphasised by the degradation of other coastal estuary systems along the East Coast of Australia, eg, the Myall Lakes. In the Wallis Lake catchment we have the opportunity to act now to ensure that the health of the catchment is maintained and hopefully improved for future generations.

This River Plan was developed following recommendations from the Wallis Lake Catchment Management Plan (WLCMP). During the development of the WLCMP, a number of pressures were identified that threaten the long-term health and integrity of the catchment. This included land clearing, weed invasion, urban development, fire management, grazing pressure, altered run-off and drainage patterns, and declining water quality. Of these, declining water quality has been identified as the main issue requiring immediate attention. Sediment and nutrient loads entering the lake system from the freshwater catchment are not sustainable and changing this pattern will be a major challenge for the community. The catchment plan has also highlighted the important role of seagrasses in the maintenance of the health of the estuary system (they are used as indicators of water quality). The management of sediment and nutrient loads will be critical for the ongoing health of the seagrass beds. One of the most effective ways to manage (ie. reduce) sediment and nutrient loads from the catchment is to stabilise riverbanks, and maintain and enhance existing (remnant) vegetation, particularly on steep land and drainage features. Research has shown that nutrient loads and sediment run-off from well vegetated catchments is significantly less than catchments with greater ratios of cleared land (Brouwer, no date).

The WLCMP identified the Wallamba and Wang Wauk sub-catchments as the two main sub-catchments requiring action to address soil erosion issues. A common theme among the recommended actions was the need for revegetation in strategic areas in the catchment, eg, riparian & drainage lines, & steep land. .

Biodiversity and environmental services.

In the Wallis Lake Catchment area approximately 44% of the catchment has been cleared. In the Wallamba catchment this percentage rises to 69%, while 18% of the Wallingat catchment has been cleared. This has lead to the fragmentation of the natural landscape, disrupting the ecological processes that underpin the integrity and therefore the function of these systems. Vegetation in the Wallis catchment is highly variable and supports a high degree of biodiversity ranging from lowland wetland ecosystems to wet sclerophyll forests in the hinterland. A total of 51 vegetation communities have been identified making up 8 major ecosystem types including;

- 11 rainforest communities,
- 10 swamp forest communities,
- 8 moist sclerophyll communities,
- 6 hinterland dry sclerophyll communities,
- 7 coastal lowland dry sclerophyll communities,
- 5 heathland communities,
- 1 sedgeland community, &
- 3 disturbed vegetation communities.

NB. For a full list of ecosystem types see appendix 7.8.

The importance of native vegetation in the maintenance and improvement of ‘catchment services’ is well recognised. Native vegetation helps to bind our precious topsoil, filters run-off, sequests carbon, and provides habitat for wildlife that can reduce the effects of insect pests. Remnant vegetation found on private land is vital to the future health of our farming landscapes. Without a diverse range of vegetation communities or ‘biodiversity’, the natural checks and balances necessary for sustainable agricultural and fisheries based enterprises will cease to function, along with the other businesses that rely on these healthy ecosystems, eg the Wallis Lake Oyster industry.

While some of the catchment has already been cleared for agriculture, the remaining vegetation is threatened by a number of ongoing pressures. The most serious threat is habitat loss due to clearing for urban and industry based development (including agriculture and forestry etc), and other uses including public infrastructure. Other threats to biodiversity come from declining habitat quality and altered habitat structure through processes such as grazing, altered fire regimes and weed invasion. Without active management to enhance and extend the catchments native vegetation, several ecological communities within the Wallis Catchment face an uncertain future.

The most serious issues identified in the WLCMP is elevated sediment and nutrient levels entering waterways, faecal contamination and the generation of acid leachate from acid sulfate soils. River bank and bed erosion is a large contributor to the quantity of sediment and nutrient loads entering the river. A combination of past land clearing, current stock management, land development and boat activity has and is causing widespread destabilisation of the riverbanks in the tidal section of the Wallamba River.

Numerous user groups utilise the estuary in different ways, eg. Recreational fishers versus wakeboarders. In addition to the cumulative impacts of different users, there is potential for conflict between different users. In planning for the future health of the Lake system, it is necessary to assess the impacts of the various activities within the context of increasing and cumulative impacts over a range of activities.

1.2 Aim of the river plan

The aim of the Wallamba River Plan is to identify the strategies required to restore, rehabilitate and maintain the environment of the river. The objectives to achieve this include:

- Improving the aquatic environment to encourage a greater quantity and diversity of aquatic flora and fauna;
- Improving the riparian corridors to enhance bed and bank stability, as well as providing a corridor for native flora and fauna;
- Promoting healthy riparian corridors as a way of increasing farm productivity and land value;
- Mitigating the effects of active erosion; and
- Improvement of water quality through the mitigation of erosion, and the interception and uptake of nutrients via improved vegetation "buffers" in the riparian zone, to benefit aquatic plants and animals, and water users on the river in general.

The plan should be formally reviewed in 5 years by the DIPNR and GLC, to assess the effectiveness of the Rivercare planning process.

1.3 Character and behaviour

1.3.1 Hydrological Summary

The Wallamba River is a relatively small river compared to the main trunk streams of Australia's east coast however it does share similarities with the bigger rivers in that it is characterised as having considerable flood variability. Australia being the second driest continent, it stands to reason that the Wallis Catchment is prone to drought. Yet, it is characterised by a summer rainfall regime that can produce high magnitude floods, where flood forecasting has to be in the order of minutes to hours to be of benefit to emergency services. In short the Wallamba River exhibits highly variable discharges (see figure 2) with the ability to cause severe bank erosion as has been evidenced in the past.

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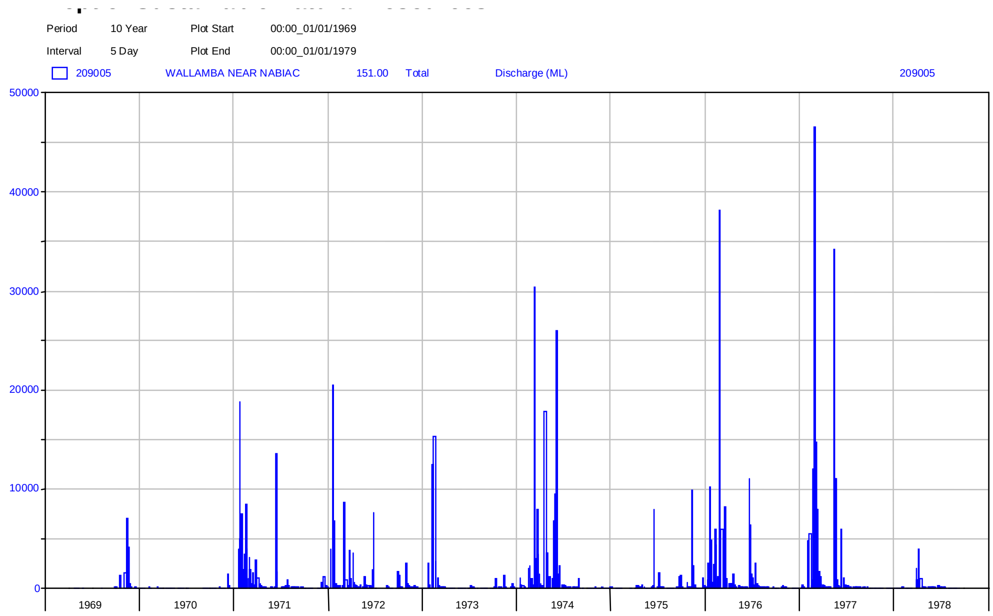

Figure 2: Flow / discharge hydrograph for Wallamba River near Nabiac.

The major flood events last century were in 1927, 1929, 1947, and 1978. The largest events were in 1927 and 1929 that saw major inundation of the flood plain including the township of Nabiac (PWD 1985). NB. Figure 2 did not record the true magnitude of the 1978 flood due to the recording station being damaged during the event!

1.3.2 General description

There are 7 aerial photos covering the plan area. On each photo, information like property boundaries, floodplain features, vegetation condition/presence, and management recommendations, is marked. The management recommendations are formulated during the riverwalk process, whereby the landholder is contacted to arrange a time when they can walk the river to discuss local and broader river issues. From this realistic options are considered to determine a practical solution to protect the river in the long term.

The plan has a water quality focus and aims to address the main findings of Wallis Lake Catchment Plan. This formed the foundation of the river Plan.

The following discussion breaks the river into sections/reaches with similar biophysical characteristics and discusses the major findings of each Reach. Reach boundaries have been marked on the aerial photographs.

In general, the Lower Wallamba is typified by a low gradient channel, that is characterised by a stable channel ie planform, grade and width are in equilibrium with sediment and water inputs from the catchment. Although there are no major channel changes in the recent times (evidenced by highly leached alluvial deposits), field inspections indicate that accelerated bank erosion is widespread, particularly where there is poor or no vegetation. Where poor or no vegetation corresponds with an outside bend, flood scour and boat wash have caused considerable damage, eg. Manns Road, and Gowack Island, and are threatening various assets.

Sheet 1

Reach 1 - The Transitional zone

Highly variable channel features typify this reach. These features include gravel bed deposits and associated island formation, pools and variable floodplain heights. These gravel deposits are similar to riffles in a freshwater river, with one currently used by a dairy farmer as crossing point and is <0.5m deep at low tide.

Bank stability is poor with the majority of alluvial banks undercut and failing. Floodplain pockets are 1-4m high, with higher sections of the floodplain very rarely inundated (>1:50yrs, ie, have an average return interval of once every fifty years), while the lower floodplain inundated at 1-2 year intervals. Higher banks (consisting of weathered podsolic soils) are stable with rock evident at toe and form the majority of the outside bends. There is considerable evidence of historic bank failure, with numerous sites now in advanced form of recovery, ie, high degree of vegetative regrowth.

Bank vegetation is highly modified by past clearing & grazing. The higher (less fertile) banks dominated by eucalypt species eg Grey Gum (*Eucalyptus punctata*), Grey Box (*Eucalyptus moluccana*), Ironbark (*Eucalyptus placita*); while the lower alluvial deposits are dominated by Flooded Gums (*Eucalyptus grandis*) and littoral rainforest species like Red Ash (*Alphitonia excelsa*), Guioa sp. (*Guioa semiglauca*) and Hard Quandong (*Elaeocarpus obovatus*). River mangroves (*Aegicerus corniculatum*) dominate the intertidal zone.

Recovery potential of the banks is high due to the proximity of local seed and climate. Unfortunately these conditions can also favour weeds, notably lantana & Madeira vine. This weed growth, if left uncontrolled, could reduce the effectiveness of the vegetation to stabilise the riverbank.

Sheet 2

Reach 2 - The Meanders

Here the river has high sinuosity, bouncing from one valley margin to another, creating a series of deep pools. The channel zone on outside bends is characterised by an asymmetric channel with tide induced point bars, while the straight sections are characterised by a symmetric channel.

Osprey, White–bellied Sea eagles and numerous water birds (eg, Pied Cormorants, Pelicans & Shags) frequent this reach, suggesting the presence of abundant aquatic life.

There is widespread slumping and bank failure from undercutting on alluvial banks without adequate vegetation, namely River mangroves (*Aegicerus corniculatum*). Floodplain height varies from 0.3m – 3m. The very low banks on Hodge/McCarthy blocks are inundated by king tides, essentially flooding paddocks. Conversely, the higher floodplains on Scanlon, MacMaster, Hodge, etc have a natural levee present and only major flood events (>1:50yr) cover entire paddocks.

There are several large wetlands on the floodplains. Currently they are over-grazed and severely modified through a network of drains and are essentially utilised as farm dams. This is compromising the wetlands ability to recycle nutrients before entering the river and ultimately the Lake system. This is contributing to the likelihood of algal blooms reaching the waterway and increasing the incidence of fish kills like the event in April 2003.

Bank vegetation is highly modified by past clearing & grazing. The higher banks dominated by either a forest of eucalypt species such as Grey Gum (*Eucalyptus punctata*), Grey Box (*Eucalyptus moluccana*), Ironbark (*Eucalyptus placita*) (on podsolic soil type) or Blackbutts (*Eucalyptus pilularis*), Red Bloodwood *(Corymbia gummifera),* Wallum Banksia (*Banksia aemula)* and Grass Trees (*Xanthorrhoea australis*) on ancient sand deposits; while the lower alluvial deposits would have been dominated by Flooded Gums (*Eucalyptus grandis*) and littoral rainforest species like Red Ash (*Alphitonia excelsa*), Guioa sp. (*Guioa semiglauca*) and Hard Quandong (*Elaeocarpus obovatus*).

The Hodge's fenced (ARL 23km) their entire riparian frontage approximately 10 years ago, due to bank erosion (attributed partly to boat wash). The majority of bank is now stabilising, as mangrove colonisation has occurred once the stock where removed. Bank vegetation is mostly thin, with some areas either patchy or infested with lantana and bracken fern. Again, recovery potential of the banks is high due to the proximity of local seed and climate. Notably, the proliferation of mangroves in the intertidal zone is common where banks have limited or no stock access.

Sheet 2

Reach 3 – Cemetery

The river straightens (meander frequency decreases) and the floodplain area reduces with the valley margin largely confining the river. Large areas of native vegetation adjoin the river providing high quality habitat and scenery. Both banks are under crown land ownership, but current land management practices are contributing to the widespread erosion of both banks.

Erosion adjacent Formston and Stacks (ARL 20km), is compromising the connectivity of riparian vegetation and inputting excessive sediment to the river and lake system. Recently, $9000 was secured from the EPA Trust to encourage mangrove recruitment and bank protection adjacent Formstons, covering approx. 175m of bank. The project trialed 4 different techniques to determine the suitability of each technique in this type of situation. Project included; coir log wall, flow net mesh fence, silt fence and rock fillet/embayment. Results to date show that all techniques can sustain minor flood flows. Structures where constructed in autumn 2003 and are yet to be subjected to the peak of ski boat use during summer.

A large proportion of the left bank is well vegetated, under crown ownership and is of high conservation significance. Erosion present as undercutting and scallops from past tree failure. Mangroves are not prolific with the dominant mangrove being the River Mangrove (*Aegicerus corniculatum*) which, unlike the Grey Mangrove (*Avicennia marina*), does not have the aerial root peg (pneumatophores) that offer greater protection of the banks.

Sheet 3

Reach 4 - Willow Point/Shalimar

As in Reach 3, there are large areas of native vegetation adjoining the river. The floodplain is generally narrow, with the occasional wider floodplain pocket (eg the land at the end of Willow Point road). The river abuts the valley margin in several locations. The valley margin consists of ancient sand deposits laid down when the sea level was much higher (approx. 170 000 yrs ago). Extensive areas of back swamps are present on the floodplain, some of which are in excellent condition. Unfortunately, numerous back swamps are over-grazed and severely modified through a network of drains, which can have an adverse effect on aquatic health, eg, fish disease, oyster mortality and the release of heavy metals (Sammut et al. 1994).

This sheet contains the most erosion in the plan area with 2-3 km of eroding banks present both sides. Soil types are highly fragile being largely composed of sandy silt deposits. Almost two years ago a 'no wash idle speed' was established. Some recovery has been observed. Small beach formation, and subsequent colonisation of beaches with mangroves and common reed is noted, as well as the build up of flood rack and eroded bank material.

This reach also has some of the best remnant vegetation in the plan area (Stacks, Forster Lands Council & Wallamba Ltd.) and is of high conservation significance. Vegetation types include riparian or floodplain forests, swamp forests, heath, and open forest. The Grey mangrove (*Avicennia marina*) becomes more abundant in this reach.

There are also some problems associated with small lot development along foreshore areas. Illegal clearing for views, garden escapees (weeds), unauthorised boat ramps and jetties, all have an impact on river condition. Future sub-divisions need to adequately address these concerns.

Sheet 4

Reach 4 - Willow Point/Shalimar

A continuation of sheet 3. The river widens with mainly narrow floodplains and occasional wider sections, notably at confluence with Bungwahl Creek. Many ski boats frequent this reach, particularly during Xmas and Easter holidays. This has contributed to the widespread erosion of unprotected banks, notably on the left bank ARL 12.5, and right bank ARL 12km. Healthy mature mangroves (*Avicennia marina*) are providing some protection on the right bank from ARL 12.5 -14km, but it appears that mangroves will only offer protection if their root matrix is >1m and adjacent bank vegetation is present.

This reach sees the presence of large amounts of camphor laurels invading both mature vegetation as well as regrowth. Large mature eucalypt trees (*Eucalyptus microcorys, E. propinqua, E. pilularis* and *E. grandis)* are present on crown foreshore adjacent Brackenridges land. Understorey is being invaded by lantana and is currently heavily grazed. Many large trees have fallen recently in this reach, with large sections of the bank severely undercut and at risk of further erosion. Extensive regrowth of Flooded Gum (*E. grandis*), and Swamp Oak (*Casuarina glauca*) along foreshore adjacent ARL 11.5 -13km, as current stocking rates are low.

Sheet 5

Reach 5 -The Islands

This reach is characterised by a large low floodplain covered in vast swamps (eg, West Swamp) and is subject to regular inundation. The river splits into multiple channels as it flows past Gowack Island and several smaller islands opposite Mann's Road. Large areas of shallow sea grass beds dominate the inside of the channel, assisting in the development of fringing mangroves, mainly the Grey mangrove *Avicennia marina*, along the adjacent foreshore and subsequent bank stability. These shallow areas limit the extent of the navigable channel.

Littoral rainforest would have been the dominant forest type with species like Tuckeroo *(Cupaniopsis anacardioides),* Lilly Pilly (*Acmena smithii),* Rusty Fig (*Ficus rubiginosa),* Red Ash (*Alphitonia excelsa),* Cabbage Palm (*Livistonia australis),* Cheese Tree (*Glochidion ferdinandi*), *Guioa* (*Guioa semiglauca) and* Soft Corkwood (*Duboisia myapororides)* present as isolated trees.

Again, erosion is present in areas with poor mangrove cover. The Lakes Way is threatened in two locations and past road relocations are evident. Upstream of Darawank Reserve bank erosion is occurring even with some bank vegetation, although mangroves are almost absent. Here the Lakes Way is <5m from the river. Also, Elliott's and Mann's Roads are severely effected with future access compromised. Boat wash appears to be a contributor to erosion processes and is particularly evident at informal turn around points.

Sheet 6

Reach 5 -The Islands

Again this sheet is characterised by the large low floodplain covered in swamps with the river splitting into multiple channels as it flows past several large islands (Wallamba & Gereeba). Large areas of sea grasses and mangrove forests are common, limiting navigable channel. Littoral rainforest would have been the dominant forest type adjacent river but past disturbance has reduced its coverage and ability to assist in bank stability to almost nil.

Main areas of erosion include; end of Mann's Road, Gereeba Island, at Kellehar's and adjacent the Mud Cut. Important to note the relationship between sea grass/shallow sections and the presence of mangroves/bank stability on adjacent bank, while the opposite bank suffers from concentrated flows from both flood and tidal scour, and boat wash.

Sheet 7

Reach 6 - The Broadwater

The Wallamba opens into the Broadwater prior to the confluence with the Lake. Extensive areas of natural oyster beds with large areas under oyster production. There is a high diversity of vegetation types surrounding the Broadwater and this vegetation is of High Conservation Value. Riparian, salt marshes, mangroves, swamp and eucalypt forests can be found adjoining the Broadwater. Of special concern was the weed infestation on the Tuncurry side of the Broadwater; asparagus, morning glory and lantana. These weeds have potential to displace native species and degrade natural values.

The Broadwater is very popular with recreational fishers and is now being promoted as preferred location for wake boarders, which has the potential for conflicting usage patterns.

Conclusion

1. Large areas of high quality vegetation types adjacent river that need protection from weeds, grazing, subdivision and boat wash.
2. Unique situation whereby the majority (75%) of riparian frontage is crown owned.
3. Very few people managing stock in riparian zone, which is contributing excessive sediment & nutrient to the Lake system, as well as degrading riparian habitat.
4. The extent of bank erosion caused by boat wash and poor land management; impacts wide spread, notably in lower sections (ARL 6-14km).
5. Number of wetlands drained with uncontrolled stock access. This is compromising nutrient recycling ability of wetlands and increasing risk of Acid Sulphate Soils, affecting water quality in Wallamba River.
6. Landholder shift; now smaller holdings, with traditional 'farmer' making way for absentee (mostly Sydney based) and 'lifestyle' farmers.

NB
Mangroves are relatively 'new' to the Wallamba River and were probably confined only to the area adjacent entrance of the Wallis Lake. Prior to European settlement the lake would have only truly opened seasonally, similar to Smith's Lake. This type of estuary is known as a barrier estuary. In ecological timeframes, the Wallamba River is still adjusting to the tidal regime introduced by the;
1. The continual opening of the Lake in the mid 1800's for navigation purposes;
2. The major increase in tidal flushing stemming from the creation of the dual training walls at Forster/Tuncurry in the late 1960's; &
3. Significant excavation activities to form the 'Cut' into the Wallamba Broadwater, and the 'Mud Cut' in the lower Wallamba River (adjacent Wallamba Island).

These adjustments include the colonisation of the tidal perimeter of the estuary by mangrove communities, effectively stabilising foreshore areas. Many sections of the estuary now have abundant mangrove forests, creating bank stability and significant aquatic habitat. Along the Wallamba River, mangrove recruitment has been limited by the amount of tidal movement and the wave action created by boating activities, mostly in 'pulse' events during major holiday periods, undercutting establishing mangrove seedlings and eroding bank.

1.3.3 Changes over time

The Wallis catchment has had a diverse and colourful past, with many changes in response to changing values, technology and economic conditions.

Aboriginal Heritage

There is extensive evidence of Aboriginal settlement of the Wallis catchment with over 100 sites identified along the coast and Lake Foreshore. These include shell middens, fish traps, campsites, burial sites, scar trees, and numerous artefacts. Three main aboriginal groups utilised the Wallis catchment; Biripi, Wallamba and Worrimi. The Biripi lived in the area between Tuncurry, Taree and Gloucester, while the Worrimi occupied the area between Barrington Tops and Forster in the north and Maitland and the Hunter River in the south. These people moved inland during winter to hunt and then shifted back to the coast in spring and early summer to fish. Tuncurry is an adaptation of the Aboriginal word for the area 'Toone-coo-ree", meaning plenty of big fish.

The Wallamba people of Wallis Lake had a central camp in the area now known as Coomba Park. Indications from middens suggest that the Wallamba clan had a diet rich in various types of seafood including shellfish, prawns, various fish and crabs. Nets were used for prawning, women fished from bark canoes with hooks made from shells and men hunted mullet on the beaches with spears. They also hunted kangaroos, wallabies and echidnas, while water birds also provided meat and eggs. Yams, berries and fruit from pigface, plum pines, black apple, lilly pillies and geebungs were also an important part of their diet (Tobwabba & Morgan 2001).

It is not known for certain how Aboriginal land use effected vegetation or other natural resources in the Wallis catchment. From early explorer descriptions, and the fact that large volumes of timber were cut from the area, we can assume that the catchment was heavily timbered and that Aboriginal communities tended to coexist with their environs. What we do know is that Aboriginal habitation of the catchment was drastically transformed following the arrival of Europeans and the consequent land use changes.

European Heritage

Following John Oxley's exploration of the area in 1810, cedar getters set up temporary camps along the rivers by the 1830's. The red cedar logs were snigged to the nearest waterway and floated to ships for transportation back to Sydney. As red cedar supplies became insufficient, other timbers like White beech, Rosewood and Coachwood were harvested. As well as depleting local rainforests these early settlers began the process of dispersing local Aboriginal clans, thus leading to the loss of tribal boundaries and lifestyle (Marr 2000).

In 1826 the Australian Agricultural Company (AA Co.) was granted a one million acre parcel of land that stretched from Port Stephens to the Manning River, inland to Gloucester and down the Karuah River. The AA Co. tried various agricultural activities with limited success with dairying, beef cattle, vegetables, poultry and pigs. The humid coastal conditions were not suitable for sheep or wheat, with footrot and liver fluke effecting sheep production, while the wheat was soft and prone to fungal attack and other diseases. The AA Co. surrendered the coastal portion of its grant, including the Wallis catchment, back to the crown in 1832 in exchange for more preferred land near Tamworth.

After the AA Co. surrendered part of their land grant, the first land grant occurred around Nabiac in 1855. Nabiac was established, along with another site near Coolongolook, as timber shipping yards. Huge quantities of timber were cut from the surrounding forest from 1860's to 1920's. As the forest was cleared, dairying gradually became popular, with milk being separated on-site. The cream was sold to Butter Factories at Darawank, Krambach and Dyers Crossing, while the skim milk was used to feed pigs. The Wallamba River was an important transport route utilised by cream boats to transport local produce. A large proportion of the catchment was cleared and replaced with pasture by the early 1900's. Clearing was concentrated in those areas with better agricultural soils, like the Upper Wallamba. Access to freshwater and poorer soils, in the lower Wallamba could have limited major development of the floodplain. This can be evidenced by the legacy of farming activities on Gereeba Island and West Swamp.

Land grants occurred in Forster in 1856 and in Tuncurry in 1875. A punt service was established in 1890 to connect the twin towns (replaced by the current bridge in 1959). Early industry in the area focussed around timber milling, shipbuilding, and fishing. More than 80 vessels were built locally providing boats for the coastal shipping and transport system. The Wallamba played an important role in this tale with timber mills and ship building yards at Failford (Mill Road and the Brackenridges Ship Yards), as well as Bullocky Wharf at Nabiac. This legacy can still be seen on paper with numerous foreshore reserves still dedicated for ship building purposes.

Harvesting of natural oyster beds growing in shallow water of the lake began in 1881, while commercial leases were established in 1884. During the first five months of the new leasing system there were 700 applications covering some 5500m of the foreshore. This system encouraged leaseholders to improve oyster banks that were destroyed by the earlier dredge harvesting (Wright no date).

The Present

The rivers, lakes and streams of the Great Lakes area have been very important to the development of the area. Prior to European inhabitation they possibly defined routes and boundaries of original Aboriginal clans. Then the timber getters came by river to harvest the moist valley floors for red cedar and other valuable timbers. Before the road and rail network was established, early coastal transport was dependent on the rivers and lakes. Today the rivers and lakes are used mainly for fishing and recreation activities. Changing land uses have had dramatic impacts on the condition of our waterways and are now vastly different to what our ancestors experienced.

Today our most valuable industries are tourism, oyster production, fishing and agriculture. Beef and dairying are dominant land uses in the upper catchment while tourism, oyster production and fishing dominant the coastal and estuary sections. Other major land uses include; forestry, conservation and urban development. Urban areas are confined largely to the coastal strip around Forster/Tuncurry.

Land use is changing with dairy deregulation, varying beef prices, rationalisation of the timber industry, the emergence of niche crops and freshwater aquaculture, a growing rural residential population dividing rural holdings (the 'Pitt street farmer'), and the increasing awareness of the importance of the environment to all industries.

Oyster production in Wallis Lake is very important with about 2.5 million oysters produced every year (approximate value $8 million/year). Oyster production dropped dramatically in 1996, not only in Wallis Lake but Australia wide, as a direct result of the Wallis Lake Oyster Contamination Crisis. Oysters are extremely sensitive to pollutants as they are filter feeders and require clean water in order to be fit for human consumption. Obviously maintaining and improving water quality in the Lake system is paramount to the future viability of this industry and the local economy.

Wallis Lake also supports the second biggest estuarine fishery in NSW. This can be partly attributed to 20% of the States seagrass beds being located in the lake. These serve an important role as a food source and habitat for post-larvae and juvenile fish, and are subsequently known as 'nurseries of the sea' (Great Lakes Council, 1997). Unfortunately surveys undertaken by NSW Fisheries (1997) indicated that vast losses in seagrass beds throughout Australia can be attributed to an increases in nutrients, turbidity, sedimentation, toxic chemicals and heavy metals.

Fish species like Sea Mullet, Luderick, Flathead, whiting, bream, and garfish, along with prawns and crabs make up the annual catch. There is very little data as to the sustainability of commercial fishery in NSW. Commercial catch data suggests that Wallis Lake is among the most productive estuaries for fin fish. However there has been a gradual decline in the catch, as well as a change in target species to commercially exploit species that were once discarded.

NSW Fisheries suggests that the fisheries resource is now fully exploited in NSW. Most of the target species of commercial fishers is the same as recreational fishers. Some studies have suggested that the catch rate is equivalent for both commercial and recreational fishers in populated estuaries, although this has not been assessed in the Wallis.

Today, beef and dairy cattle are the main agricultural pursuits. Australia Bureau of Statistics indicate that beef production for the Wallis catchment contributed $1.5 million per annum, while the dairy industry was valued at $3 million per annum.

In 1999 there were 48 dairies operating in the Wallis catchment with a total herd size of 3050. Since deregulation in 2000 there has been a dramatic decrease in operational farms with less than 30 dairies in 2001 with a total herd size of 2550. From this you can interpret that although farm numbers have decreased the average herd size has increased. This intensification of farm practises, which has been market driven, obviously has implications for the environment due to increased pressure on natural resources. The challenges for farm managers is how to implement environmental management systems that can reduce the impacts associated with increased herd sizes and stay viable, in a market that has seen milk prices reduce by more than half in less than 5 years.

Tourism is a major industry in the Great Lakes area, with an estimated 1.25 million visitors annually. This trend is expected to increase. Recreational activities are mostly water based and include fishing, boating, water skiing, sailing, surfing, and swimming. The tourism industry is a great promoter of the natural values of the catchment and, like all other industry, is reliant on the protection of these assets to maintain and provide for the expected increases in tourist numbers and the local population.

The Wallamba River is currently utilised by many locals and tourists alike, all of which come to experience and enjoy the ideal conditions of the river for water skiing activities, and to a lesser degree fishing. Unfortunately, the past and current usage patterns is compromising the natural values of the river through the degradation of riverbanks. Given the predicted population increase on the mid north coast and the ever increasing popularity of the water base sports like wakeboarding, aquaplaning and water skiing, these impacts could also be expected to increase.

1.3.4 Where to now

The challenge for the government agencies and the community is to develop a strategy that is equitable to both the river and its user's. One of the contributors to erosion processes along the Wallamba is boating, the other is land management. The current devolved grant scheme, which Great Lakes Council is administering, is addressing land-based issues, but boating remains largely self-managing. Continued incentives and support for landholders interested in natural resource management must be maintained.

Several of the recommendations contained in the plan state that certain areas of the river should limit skiing activities, with Waterways already contemplating the limiting of specialised wakeboarding boats to the Wallamba Broadwater and other areas of the Lake, effectively banning them from the Wallamba River. Boating on the Wallis system should be addressed as a whole. The Waterways Authority has recently developed a Boating Plan of Management for Smiths Lake. A similar plan needs to be formulated for Wallis Lake.

Short-term solutions that could reduce the current extent of impacts associated with boating on the Wallamba include the introduction of a levy/license type system to raise funds for river restoration works, as well as a code of conduct that promotes low impact skiing activities and practices. Education plays am important role in the communication of management changes. To this end Great Lakes Council is negotiating with Waterways and DIPNR to co-fund a 'Riverkeeper'. A 'Riverkeeper' is a surrogate Waterways Officer housed with Waterways in Forster and would have the role of educating boat user's on the Wallamba, as well as enforcing the code of conduct and other waterways regulations.

Longer-term options include the construction of purpose built ski parks, like the facility at Telegraph Point and Penrith Leagues Club, Sydney. Purpose built ski parks could alleviate the pressure while opening other opportunities to other user groups including; nature/fishing tours, kayaking etc. The suitability of the Wallamba to sustain the increasing numbers of boat user's in the long term, from both an erosion & safety point of view, is problematic. What we do know is that the mid north coast is about to under go a rapid population increase and the impacts associated with this increase will be felt across our whole landscape unless careful planning and management are exercised.

2.0 Landholder Information

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Colour aerial photo of individual property to be inserted in Booklet
or see A1 colour aerial photos Sheets 1-7. (Located at GLC, Breese Parade, Forster 2428; or DIPNR, Victoria Street, Taree 2430).

3.0 River and Catchment Processes

3.1 Formation of Wallis Lake

Wallis Lake has evolved as a result of fluctuations in sea levels and the deposition of sand barriers following past ice ages. About 120 000 years ago, the sea level was about 3 metres higher than it is today and many of today's coastal beaches did not exist. The coastline at this time would have lay along the western side of the lake with Cape Hawke hills forming offshore islands (Melville in Webb et al, 1999).

During periods of lower sea levels (approx. 17 000 years ago and up to 120m below present sea level) estuaries extended further seaward onto the continental shelf. During the period that followed the sea level began to rise, vast quantities of sediment was reworked and transported landward across the inner continental shelf as landward moving sand sheets and barriers (Chapman et al, 1982). The lower coastal plain and the river valleys were flooded and the main lake was impounded behind one such barrier, which was transported and deposited between Cape Hawke and Booti Booti by the rising sea. North of Cape Hawke the sand from a previous ice age formed a series of dunes which developed eastwards to eventually occupy the embayment between Cape Hawke and Hallidays Point.

Throughout the north coast of NSW, two distinct barriers are apparent: the Outer and Inner Barriers. The outer barrier consists of a belt of beach, dune, estuarine and lagoonal sediments from the Holocene age (<10 000 years ago). The eastern edge of the outer barrier forms the present day coastline of NSW. Landward of the Outer barrier is a second belt of marine sediments, referred to as the inner barrier. Radiometric dating of the humus, corals and shell has indicated that these Inner Barrier sands are from Pleistocene age or 140 000 to 90 000 years before present. The inner barrier can be seen as sand deposits near between Failford and Nabiac. The Outer and Inner Barriers are often separated by an inter-barrier depression, which can lead to the creation of such water bodies as Wallis Lake.

This evolution of the Wallis estuary has been determined by the degree of barrier formation. This has in turn been determined by the inherited coastal topography. As the sea level reached today's point about 6000 years ago, extensive outer barriers were formed across the mouths of broad shallow embayments like Wallis 'Lake'. On the landward side of these barriers, estuaries were produced in the form of broad tidal lakes connected to the ocean by tidal inlets through the outer barrier.

In some estuaries, flows were insufficient to maintain permanent entrances. In deep narrow mouthed embayments like Port Stephens (Nelsons bay) and Port Jackson (Sydney), these barriers of sand where unable to completely fill the mouths and remain as submerged bars, while the estuary developed as a drowned river valley with a wide deep mouth.

Roy (1984) classified the estuaries of NSW into three main groups with four stages of maturity. They are as follows;

1. Drowned river valley estuaries;
2. Barrier estuaries: &
3. Saline coastal lakes.

The different stages of maturity within each estuary reflect the gradual infilling that began 6000 years ago. Infilling has occurred from marine sand moving into the estuary by winds and tides, by fluvial deposits from the upper catchment and from the accumulation of sediments and calcareous by molluscs, plankton and diatoms.

Obviously, infilling rates vary between estuaries because of catchment size, lithology, topography, coastal setting and the geographical location of upstream catchments. Therefore, despite the common age of NSW estuary systems, a diversity of stages of maturity exists.

Wallis Lake is classified as a Barrier Estuary in early stages of maturity. It is characterised a small upper catchment area, with consequent sedimentation rates that have occurred since sea levels stabilised has not been sufficient to in fill the lake (unlike the Manning estuary for example).

3.2 Estuary Processes

An estuary is the name given to the lower reaches of a river or lake where freshwater meets saltwater. The word estuary is derived from the Latin term 'aestus', meaning tide. Usually, an estuary is defined in terms of the limit of oceanic salt water, moving upstream under the influence of the sun and moon, or the tide. However this definition does not include the many lakes, lagoons and wetland areas found on the East Coast of Australia.

A broader definition of an estuary should take into account the diversity of habitats associated with estuarine areas. Hutchings and Collett (1977) define an estuary as the tidal portion of river mouths bays and coastal lakes, irrespective of the dominance of hypersaline (brackish), marine, or freshwater conditions. This definition includes the inter tidal wetlands, where water levels can vary in response to the tidal levels, along with perched freshwater swamps and coastal lagoons which are intermittently connected to the ocean. This definition could also be expanded to include all areas of the floodplain as during high flow events (floods) they are connected to and can impact on the estuary system.

In hydraulic terms the upstream boundary of an estuary is the limit of tidal influence. In many estuaries this tidal limit is considerable distance upstream from the salinity limit. In the Wallamba, where tidal behaviour is curtailed by the weir at Clarkson's Crossing, the tidal and salinity limit has been artificially imposed.

Water movement within an estuary

While the above discusses the estuary as an isolated definable body of water, an estuary is obviously connected to the rest of the catchment as the estuary conveys freshwater runoff to the ocean. Catchment activities affect the quantity and quality of water flowing to the estuary, often containing high levels of sediment and pollutants that can be detrimental to the estuary system.

The movement of water in and out of the estuary is influenced by tides. Freshwater flows are generally small, except during floods, but can have significant effect on water quality. Most of the catchment runoff occurs following major rainfall events. During flood events the main lake area acts like a retention basin at high tides, storing the flood flow until low tide where it is discharged into the ocean (Webb & Associates 1999).

After floods the waters in the lower estuary soon return to marine conditions. Webb & Associates (1999) suggests that the waters downstream of the Wallamba Broadwater are exchanged within one week, while the Broadwater itself is exchanged after two weeks and the upper sections of the Wallamba the exchange period increases to over 2 months. This is in part due to the tidal restrictions imparted by The Cut, The Mud Cut and further upstream at Failford at the 'Cattle Crossing'. This certainly has implications for water quality and underlies the importance of best management practices focussed on improving water quality in the upper Wallamba. The fish kill at Nabiac in April 2003 is testimony to this fact.

As discussed previously, saline waters are carried into the lake by the tides, while the freshwater tends to wash the saltwater back toward the ocean. The presence of saline water in an estuary produces a longitudinal density gradient. This results in the enhancement of flood tide velocities near the bed and ebb tide velocities near the surface. This behaviour leads to residual currents, whereby saline water flows along the bed upstream, while freshwater flows downstream near the surface. This is referred to as 'gravitational circulation' and is an important mechanism for sediment transport upstream.

Wind driven currents can also be important vectors of pollutants and can also contribute to erosion processes. Wind shear at the surface produces surface currents, counter-balancing currents at the bottom of the water column, resulting in lateral circulations. In poorly flushed systems, like the Wallamba River, wind driven currents can be one of the main contributors to water movement and mixing in low flow conditions.

Also, in shallow estuaries, like the Wallamba, tidal movements cause fortnightly tides. This tide gives rise to a net circulation of tide waters over a 2 week period, leading to the net upstream trapping of residual water.

These flows can have a major effect on the distribution of dissolved pollutants with major implications for water quality. They can be mistaken for the effect if increased freshwater flows or tidal surge caused by meteorological effects.

Sediment Sources

Different types of sediment are supplied to an estuary from various sources. There are three main types of sediments;

1. Fluvial mud's (silt and clay), sands and gravels from catchment runoff (eg. Upper Wallamba);
2. Reworked coastal sand from the inner barrier (eg. Failford); &
3. Beach and near shore sands from littoral processes.

Filter feeders like oysters remove particles from suspension and eject them as agglomerates, which settle from suspension to the bed. Here they can be stabilised by diatoms and benthic algae that utilise this substrate as a growing media. Seagrasses also reduce tidal velocities near the bed and wave action on top of marine sediments, hence encouraging the deposition of further material.

Sediment Movement

Sediment particle can be moved by water in three distinct modes of motion.

1. rolling or sliding;
2. hopping (saltation); &
3. suspension.

Flowing water exerts shear stress on the bed of a waterway. The faster the water the greater the stress and the greater the bed load transport. When energy level exceed the critical value required for motion, sediment particles begin to roll or slide. As the velocities increase further the particles begin to jump or hop, until velocities become so great that the water lifts them into water column or suspension.

This transportation of sediment particles by rolling and hopping is known as bed load transport, while the transport of suspended particles is known as suspended load transport. Bed load transport and suspended load transport often occur simultaneously and the transition between both modes is not well defined. Bed load transport is dependent on water velocity, with the rate of transport varying with the cube of water velocity. Therefore slight changes in velocity can have major effects on the rate of transport.

Factors Effecting Sediment Movement

There is generally three main principles governing sediment movement.

1. Sediment transported in water will settle at places of low energy. The rate of settlement will depend on the grain size, mineralogy and chemistry of the sediment;
2. Sediment on the bed will be eroded and transported when the energy levels exerted by tidal, wave or flood action, in combination or isolation, exceeds the critical shear stress value. This value also varies according to the grain size, mineralogy and chemistry of the sediment; &
3. Sediment that is deposited where critical thresholds are not exceeded regularly can consolidate, increasing in both strength and density. As bed strength and density increases so does the critical shear stress value required for erosion, thus becoming more stable and less likely to be eroded by natural processes.

The main mechanisms for sediment transport are the currents caused by freshwater flows and tides. Bed load transport is the principle mode by which sand is moved in estuaries and the Wallis is no exception.

Tidal transport rates are sensitive to changes in velocity, such as those brought about by tidal distortion and gravitational circulation. These two forces generate residual bedload flux in an upstream direction. These two processes result in a strong net upstream transport of marine sand that form shoals and deltas in the lower estuary areas.

Freshwater flows during large flood events are much greater than peak tidal flows. Thus floods can transport large volumes downstream, depositing sediment at the entrance bar. After the flood the deposited sediment can be reworked and the process begins again.

Wind generated waves can have significant effect on sediment production and movement along exposed estuary foreshores. Within the narrow confines of river estuaries, like the Wallamba, wind generated waves are small and of short wave length. When the dominant wind direction is aligned with a long straight reach of the river, wind waves can cause erosion of riverbanks, especially if riparian vegetation has been cleared or compromised by poor land management practises.

Stream management problems can arise from changes to processes in the river system, eg the introduction of boat wash. River erosion is often a combination of these processes. Rivers are dynamic systems that are susceptible to a higher rate of change than other landscape features simply because they transport concentrated volumes of flowing water and sediment. The pre- European rate of change was extremely slow compared to that which is presently experienced along the Wallamba. Although Wallamba River still retains many natural features and is relatively stable in planform, the rate and extent to which it is eroding has never been so high in its history as it is today, owing to past & present management.

4.0 Rivercare Plan Recommendations

The management recommendations on the Rivercare plan range from broad goals to specific actions. This reflects the variety of actions needed to improve the stability and health of the river and to assist 'recovery processes'. The Rivercare plan identifies the activities needed to improve the condition of the stream. Consequently, the Rivercare plan provides a sound basis on which to set priorities for managing the stream. The more specific management recommendations on aerial photographs have been colour coded as a guide to the priority. Red indicates high priority recommendations, while blue indicates medium to long term priority for management recommendations. The prioritisation of these recommendations is the opinion of the author at the time of assessment of the site, and will change over time as a result of natural processes altering site characteristics. They take into consideration the concerns of the landholder, the potential to increase/reduce stream degradation in the short term and long term, and the importance of implementing the action for ecological, economical and social reasons.

The broader management actions in the Companion Booklet are aimed towards addressing ways of dealing with the main issues described, both in the short and long term.

Property Planning is recommended as a means of integrating stream management with whole farm planning. The benefit of Property Planning is useful, as it is up to individual landholders to determine how these Plans can be achieved for their particular situation.

Some of the management options will be within the capability of landholders to achieve, while others will require financial and/or technical assistance. Advice of a technical nature and on funding assistance can be sought from the Manager Natural Systems, Great Lakes Council on (02) 6591 7274, local Landcare Co-ordinator on (02) 6554 1655, or the Department of Infrastructure, Planning and Natural Resources (DIPNR), Taree Office on (02) 6552 2788.

4.1 Issues and actions

This section of the Companion Booklet aims to give the Wallamba River community strategies to tackle the issues raised in the river planning site visits. The strategy identifies and discusses the issue, then suggests actions to be taken to address that issue.

The issues identified during meetings and site visits included:

- River bank and bed erosion;
- Stock damage to stream banks and riparian vegetation;
- Foreshore reserve management;
- Lack of a wide and diverse native riparian vegetative buffer;
- Water quality;
- Weeds;
- Acid sulphate Soils;
- Log jams/snags; &
- Fish passage blockages.

4.1.1 Riverbank erosion

Riverbank erosion is the most significant and widespread problem confronting the future management of the Wallamba River. With over 23km (approximately 40% of river length) of active bank erosion requiring bank stabilisation efforts, and the remaining under threat from poor land management practices, river health can only be expected to worsen unless sustainable land use solutions are implemented. The following discusses the specific process of erosion as it relates to the Wallamba River and raises solutions to arrest bank erosion. Broader river processes are contained in **appendix 8.2**.

The most common forms of bank erosion along the Wallamba River are;

- collapse after undermining;
- slumping; and
- overland flow entering river.

There are several variables involved with accelerated bank erosion problems in estuarine settings. These include:

1. Stratigraphy of the bank itself (sediment type, cohesion etc.).
2. Quality and extent of riparian vegetation (including 'large woody debris' input).
3. Presence/absence of groundwater springs in the bank profile (groundwater seepage at the base of the bank will tend to encourage bank slumping).
4. Aspect of the bank with respect to prevailing winds.
5. 'Fetch' in front of the bank over which prevailing winds can operate to produce wind generated wave action.
6. Exposure of the bank to total boat wash wave energy.
7. Exposure of the bank to fluvial scour from tidal flows.
8. Exposure of the bank to fluvial scour from flood flows.
9. Adjacent farming practices.

Clearly, at any given location, the contribution of each of the above factors varies. In general it should be noted that riparian vegetation has been significantly altered since European colonisation and in some cases is now entirely absent. Before riparian forests were cleared the wind generated wave energy was considerably less than it is today because the forests acted as a windbreak. Furthermore, the tree roots provided physical bank reinforcement and water taken up by this deep rooted vegetation tended to keep the banks drier. These factors helped to limit both wave notch development at the base of the bank and slumping through bank saturation. Another important function of riparian forests is to supply 'large woody debris' (LWD). Reports from early explorers and settlers relate how the channel margins were often a tangle of fallen trees and limbs. This jumble of LWD at the toe of the bank gave both physical protection to the bank and provided ideal conditions for mangrove establishment. The practice of 'de-snagging' for navigational and aesthetic reasons, coupled with the removal of the source of the LWD, ie removal of riparian bank vegetation, has led to the loss of this important bank stabilising function.

While the riverbank's natural ability to stabilise itself has been reduced through the processes described above, the amount of erosive force arriving at the bank face has increased. Partly this is due to the loss of the windbreak effect of riparian forests, but boat wash can also provide a significant contribution. Clearly, before the advent of modern powerboats, this erosion source did not exist.

The net result of the changes described above is the eroding landscape that we see today. The following figures summarise the undercutting erosion process most common on the Wallamba River.

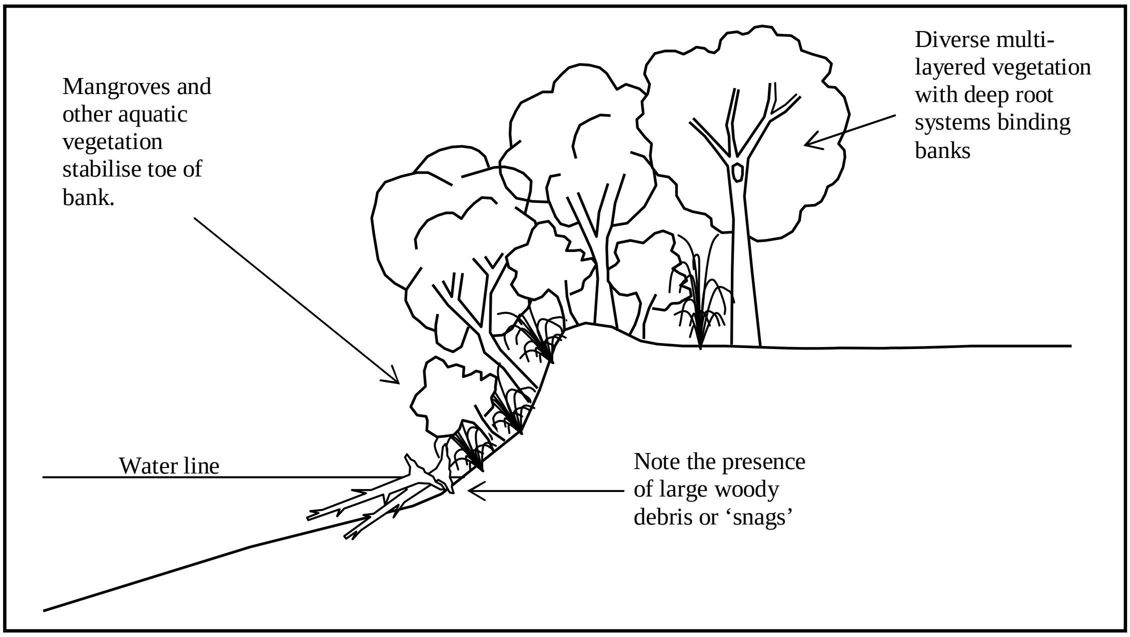

Figure 3: A stable bank in pristine condition.

Large woody debris in front of the bank provides both physical protection and is encouraging local areas of sediment deposition. Mangroves and other aquatic plants tend to colonise at the toe of the bank under these conditions. Mature upper bank vegetation further re-enforces the bank by reducing flood flow velocities, binding soil and reducing bank surcharge.

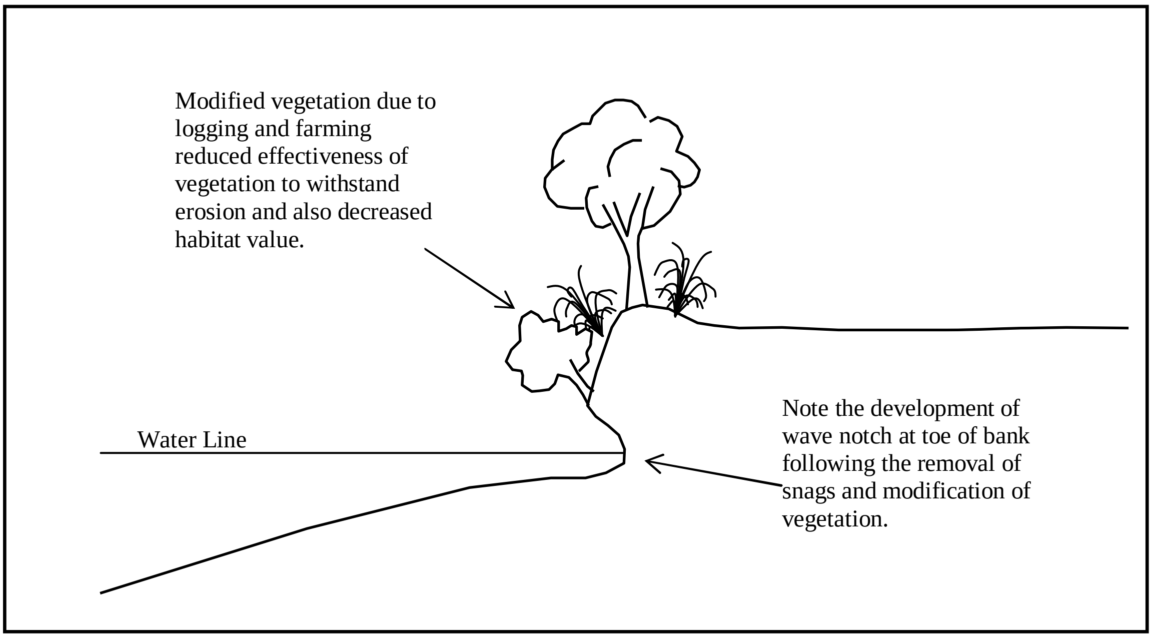

Figure 4: LWD protection has been lost and bank vegetation has been modified.

There has been a significant increase in wind wave energy reaching unprotected banks due to this modification. Furthermore, natural wave wash from wind generated waves has increased due to the introduction of wave wash generated from boating activities. The rate of development of the wave notch is related to the localised wave climate and the composition of the bank material.

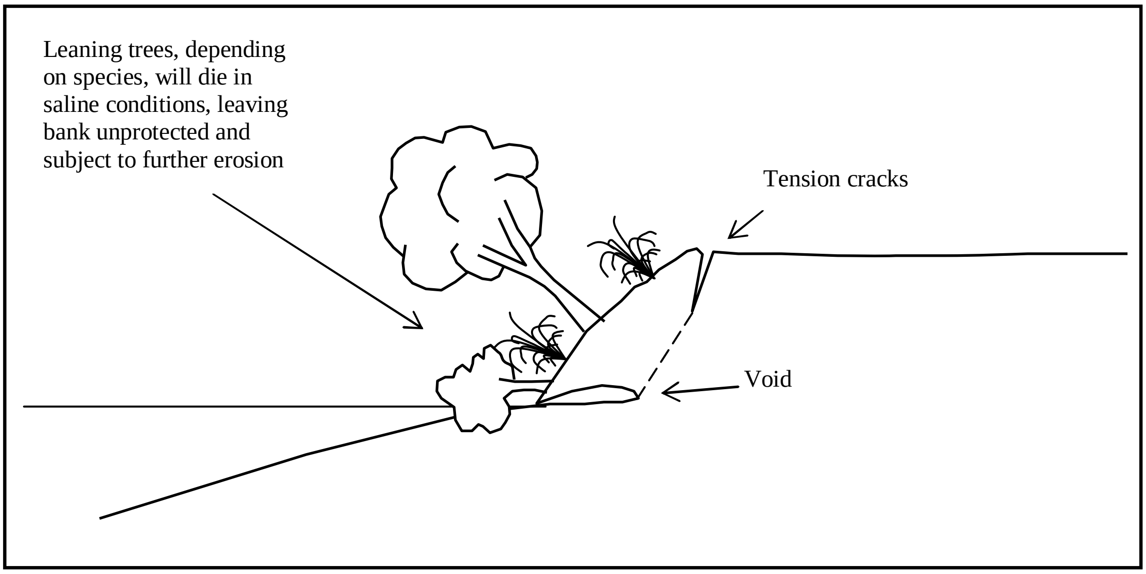

Figure 5: The wave notch has developed to such a stage that bank collapse has occurred.

Tension cracks are clearly visible on the upper bank, trees are leaning into the water and a void may exist under the root ball. In advanced cases the tension cracks may link up to the void to create significant holes in the upper bank. NB This situation may prevail for some time, as some trees are able to survive this slumping eg *Casuarina glauca* (Swamp Oak) seem particularly well adapted. As the entire root ball of the tree is now resting on the bench at the base of the bank, the physical protection provided may minimise further erosion for many years.

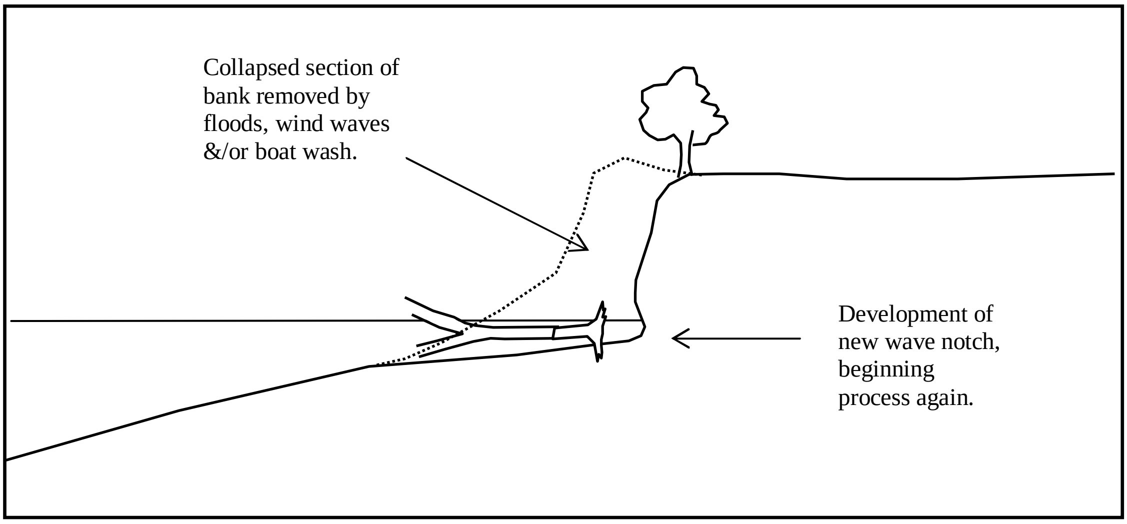

Figure 6: The slumped trees and bank material have been removed by floods &/or continued wind &/or boat waves.

Clearly slumped vegetation, as described in Figure 5, is less stable than the situation depicted in Figure 3. The entire slumped area is prone to being removed by large floods and/or high wind following soaking rain when the trees will finally fall into the channel. If the trees that have fallen in become lodged at the base of the bank (either naturally or are physically moved and secured there) then the bank may start to stabilise again as depicted in Figure 3. If however, the freshly created LWD is either washed away or mechanically removed, then the situation, as depicted in Figure 6, will exist. Here, there is no LWD protection and little significant upper bank vegetation left. A new wave notch will develop and the process will start all over again, only this time faster as there is now no significant upper bank vegetation to arrest the process.

Figure 7: Example of Bank erosion opposite Gereeba Island, ARL 5km.

Note the exposure of the water supply line, the plume of sediment immediately adjacent bank and the slumped bank material.

Figure 8: Slumping at ARL 21.5km.

Bank slumping is less common occurrence on Wallamba River. It typically occurs on the higher banks where vegetation has been cleared adjacent the riverbank, and where there is a lack of stock control in the riparian zone. It usually occurs on very wet banks where springs are discharged into the river. It frequently occurs after floods when the increase in shear weight from the saturated bank, causes the bank to collapse.

Wave Action

One of the contributing factors to accelerated bank erosion along the Wallamba River is boat wash. Cowell (1996) suggests that many previous studies have under estimated the energy produced by boat wash. Also he proposes that boat wake constitutes up to 70% of the total wave energy reaching a given bank in sheltered estuaries. This can be supported along the Wallamba River, as the amount of wind wave wash reaching the banks is very low due to the narrow nature of the river, and the level of roughness afforded by surrounding vegetation. These features have led to the popularity of the river to boat users, as even when there is a substantial wind blowing, there is very low frequency of wind generated waves. Conversely the frequency of boat generated wash in the favoured ski reaches is extremely high. This is particularly the case when 40-50 boats are utilising the river at one time.

The cumulative impact from two or more boats is obviously greater than one, which previous wake studies have often ignored. Excluding the effects of wake interaction tends to cause underestimation in assessing the degree to which bank erosion is attributed to boat wash (Cowell 1996). The underlying assumption is that when two boats pass, the wakes caused buy the boats can either cancel one edge of the wash but can amplify the other edge.

The legal requirement is for both the vessel and the towed person to be at least 30m from other vessels not towing skiers, the shore, jetties, moorings, pump inlets, bridges, and 60m from persons in the water. The width of the Wallamba varies between 20 & 100m. This means that if two boats towing skiers were to pass each other then the minimum width of the river would have to be at least 90m wide. Many sections of the river are physically not this wide or due to shallow sections (seagrasses), make the navigable channel substantially less than the actual channel. Given this scenario and the fact that numerous boats can pass each other at one time, then obviously many breaches of the Waterways regulations are occurring. Many passes occur less than 5-10m from the bank, particularly in narrow reaches with sea grass beds, eg Gowack Island, adjacent Darawank Reserve and Mann's Road.

Information contained on the Waterways Authority Internet site suggests that "boat wash is the turbulence created by a boat as it moves through the water. Wash size and influence is affected by the amount of water a boat displaces, the boat speed, its planing attitude and other factors such as water depth. This means that a cruiser moving through the water at 8 knots will displace a large amount of wash – big enough to capsize a small dinghies, damage moored boats and contribute to foreshore erosion. A high performance ski boat, however, will create almost no wash when it is planing."

Thankfully there are not many cruiser's utilising the Wallamba River. However, there are large numbers of high performance ski boat using the river, and they do not create substantial wash but given the frequency of boat passes in high use periods, the cumulative impact is contributing to erosion on unprotected banks. Also, high performance ski boats do not always stay on the plane and can be regularly seen 'half planing' or travelling at intermediate speeds. This occurs either when a skier has fallen or due to the crowded conditions on the river, the boat for safety reasons chooses a slower speed. Scholer (1974) suggests that this was also observed during his study in the Hawkesbury River. He goes on to add that, as waterways become more crowded that the interval of lower speed runs and high wave generation increases proportionally.

Bonham (1993) suggests that there is an increase in the horsepower of high performance ski boats but little refinement of hull shape, consequently an increase in boat generated wash. He also adds that the energy of boat wash is unprecedented in nature, given the sheltered nature of the popular skiing locations in NSW waterways. He also suggests that grey mangroves are capable to some extent at dissipating boat wash, particularly at high tide. Bonham (1993) proposes that at low tide the edge of the mangrove root matrix can be exposed and undermined by boat wash, displacing mangroves in the long term. This was also noted on the Wallamba. Additionally, during king tide events, which coincide with the summer high use period, waves have been observed flowing over mangrove roots and eroding the banks behind the mangroves, especially when the bank has poor bank vegetation. Mangrove root matrix appear to have to be greater than 1m in depth to be of any benefit for wave dissipation. Unfortunately, there is limited distribution of mangroves in highly eroded areas of the Wallamba.

Purpose built wakeboarding boats (boats that carry pump-operated bladders used as ballast to lower the tail of boat and maximise wash height. Some boats also have a modified drive shaft that also 'pulls' the tail of the boat down to increase wave height) have introduced a new level of wave energy and are of considerable concern with some boats producing an incredible 1m high wave. Unfortunately the effect on the bank, particularly an unprotected bank, is devastating with the wave impacts being felt when standing on top of bank, with wash been thrown up to 3m into the air and into adjacent into paddocks, with the salt laden water damaging vegetation. The frequency of the wave attack from these boats is extremely high, with multiple passes common, due to the amount most wake boarders seem to fall, causing the boat to return at low speeds. Numerous boats have been observed executing power turns that concentrate wash toward one bank, when returning to retrieve fallen boarder.

The tourism benefit associated with skiing activities is undeniable. The high numbers of boats utilising the river is having an impact of the other values associated with waterways. Given the popularity and increasing numbers of people moving and visiting our area to enjoying wakeboarding, water skiing and other skiing activities, the problem can only be expected to worsen if left un-managed. In the short term we can repair eroded banks, at a cost, but we must look at future management decisions to improve and protect our unique Lake system.

To develop and implement river management strategies, it is important to understand the processes that have shaped/formed the river and what processes are now 'impacting' on the river. The combined effects of tidal influences, wind/wave and floodwater energies have always posed a threat to the stability of the banks of Wallamba River. However, up until the relatively recent past they have been offset by the resilience provided by mature riparian vegetation. In a process of adaptation, the vegetation that naturally occurs on the banks of the creek has evolved such that it can recover even after the largest of floods.

Erosion control techniques

Once a bank has eroded, depending on the cause, it may be necessary to develop bank restoration strategies. There are two main types of strategies; protection and stabilisation. Bank protection involves the construction of physical protection structures like rock or log walls. Bank stabilisation is the stabilisation of the bank through revegetation, be it planted or encouraging regeneration, to increase the strength of the bank to resist future failure. The combination of both strategies greatly increases success and increases the ecological benefits of your efforts. The simplest, and by far the cheapest, bank stabilisation technique is the erection of a fence to manage stock and encourage natural regeneration. This will only succeed if the process of erosion has changed.

<u>Hard Structures</u>

The main erosion process impacting on the banks is boat wash. Without the removal of all boating activities, erosion will continue unabated. Given this scenario, a physical bank protection strategy is necessary along large sections of the river to halt erosion processes. Over the years numerous bank protection techniques have been trialed, including:

- Dumped builder's rubbish;
- Car tyres;
- Timber revetment walls;
- Rock gabions;
- Rock revetment.

The preferred method in the past has been a form of Rock revetment or Timber revetment walls. The major drawback of these methods is that it does little to regenerate mangroves, and while it represents a significant improvement on a sheer eroding bank, it still falls short of providing the biodiversity values of mangrove communities. Revetment techniques are suited to areas where a deep channel abuts the bank and there is no beach at low tide, and in this scenario can be only option.

Dumped builder's rubbish and car tyres are not recommended due to the reasons mentioned above, as well as other potential environmental implications, eg leachate production from tyres, and the unknown constitution of builder's rubbish. Rock gabion cages tend to degrade in the saline conditions and associated repair costs can make them difficult to justify.

Previous attempts at re-establishing mangroves have met with mixed results. In low energy areas, stock exclusion is usually sufficient to allow prolific regrowth, but in high energy areas (i.e. areas with strong wave action) mangroves do not regenerate well, even when stock are kept away. In these instances it has been commonly observed that while seedlings may initially establish in good numbers, they are soon undercut and wash out.

One method becoming popular in bank protection is the construction of rock fillets or wave energy dissipaters. Essentially, the rock barrier replaces the role formerly played by large woody debris. Prior to European settlement the area in front of the riverbanks was a mass of fallen timber which provided physical protection, trapped sediment and acted as a nursery for mangroves. By the time the timber rotted away, the mangroves were either big enough to fend for themselves, or more large timber had fallen out of the forest to provide continued protection. Rock fillets are designed to mimic LWD.

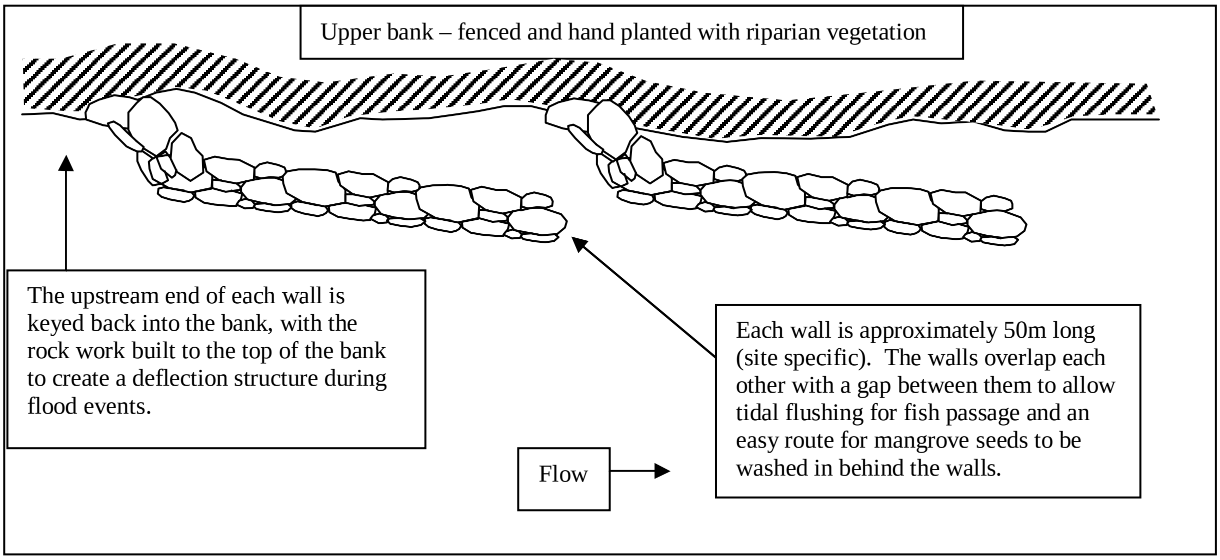

Figure 9: Plan view sketch of typical Rock Fillet wall arrangement.

The rock wave barriers are made up of a series of rock walls laid parallel to the bank and overlapping each other at the downstream end (see Figure 9). This design is used to allow fish passage and the recruitment of mangrove seeds to the area behind the walls at high tide. The upstream end of each wall is curved through $60\text{-}90^0$ and taken to the top of the bank. This creates a rock deflection structure that protects the bank from high velocity flows along the bank face during floods. Walls are generally constructed to the height of mean high water.

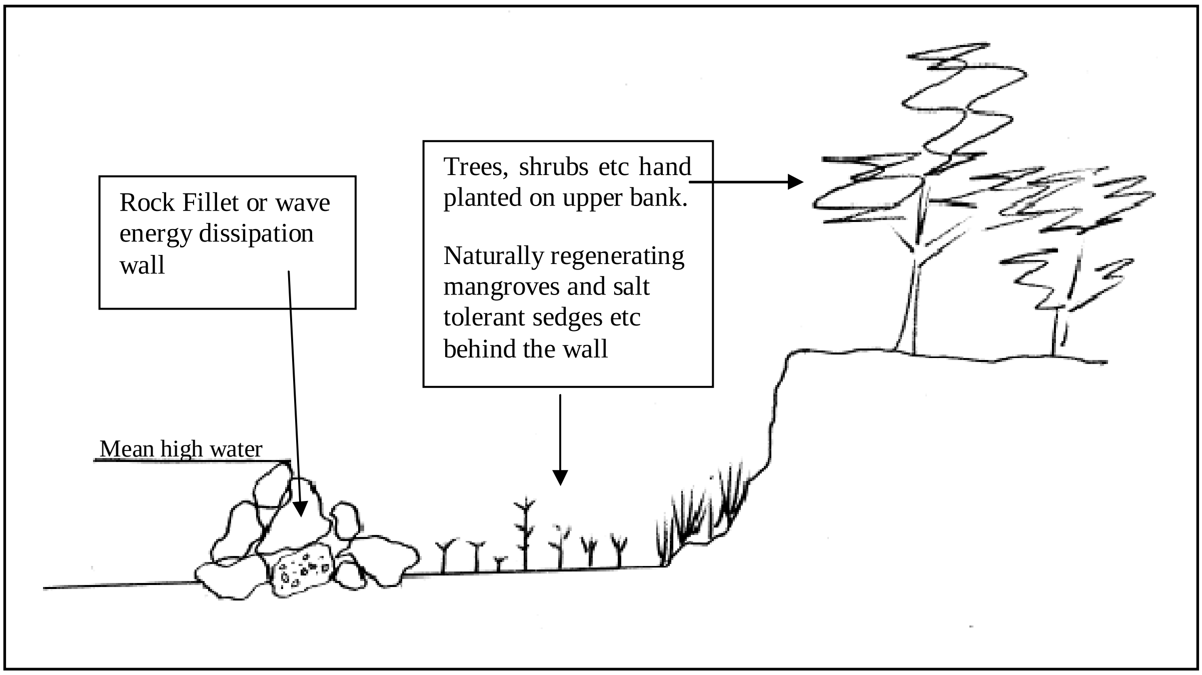

Figure 10: Cross-section showing the layout of a typical rock fillet project.

Rock wave energy dissipation walls are constructed parallel to the eroding bank. The distance from the bank depends on the slope and extent of the bench in front of the bank, and the reach of the machine used to place the rock. The wall is built to a height that corresponds with the mean high water. Mangroves and other salt tolerant shrubs and sedges will establish by natural regeneration where a seed source exists. The job is completed by hand planting an upper bank buffer of riparian trees and shrubs, or by encouraging natural regeneration.

The cost of constructing a project of this design is heavily dependent upon the local quarry rock prices, transport costs, and the machine hire to place the rock. As the cost of rock is very variable the prices quoted here can only be used as a guide. With rock delivered to site at the rate of $35/m^3 the price of such a project is $100/meter of bank treated.

The technique outlined represents an ecological solution to the problem of accelerated estuarine river bank erosion in high energy areas, ie those areas that are exposed to high levels of wind generated wave action and/or boat wash. It has significant advantages over traditional bank protection methods such as rock revetment, as the whole design is focused upon establishing a wide band of mangroves in front of the eroding bank, as well as re-establishing upper bank revegetation.

Figure 11: Project site pre-construction at Dumaresq Island in the Manning River, October 1999.

The bank had been eroding at the rate of approximately 500mm/year for many years. Wind generated wave action was cutting a 'wave notch' at the base of the bank which led to bank failure by sloughing. The talus (deposited bank material) was then removed by subsequent wave action and the process started over again.

Figure 12: Same location as above, August 2002.

The installation of wave energy dissipation walls has led to the natural regeneration of mangroves by the hundreds. As the formerly vertical bank stabilises the slumped material is consolidated by salt tolerant shrubs and sedges, and mangroves (self-seeded). The area behind the walls is now a zone of net deposition. Sediment now accumulates were accelerated erosion was previously taking place.

'Soft' structures

Hard engineering structures, like those mentioned above, are not always feasible due to financial constraints of landholders. Additionally, these types of structures are not always necessary, eg lower energy sites. In this situation soft' structures maybe an option. These 'soft' structures operate on the same principles as the 'hard' structures, where by they aim reduce wave action reaching the bank, hence encouraging vegetation and sediment deposition, be it slumped bank material or flood deposits (see Figure 14).

Figure 13: Coir Log Wall and Rock Fillet riverworks at ARL 19.7km.

Figure 14: Sediment deposited behind recently constructed coir log walls, by May 2003 fresh.

Typical 'soft' bank protection structures include;

- Coir logs (see figure 14);
- Silt fence or other geotextile product, eg Flow Net; and
- Brushing, ie logs of various sizes and other debris secured to bank or bed.

There are numerous other permutations of both 'hard' and 'soft' bank protection structures. The most appropriate for an individual site will depend on energy level, and cause, at the bank, and the financial limitations of individual landholders. Obviously, the degree of risk is greater with 'soft' structures as they can be severely damaged by high magnitude floods and require regular maintenance and follow up. The main advantage of the 'soft' structures is that they can be installed at little cost to the landholder as the labour component can satisfy the 50:50 funding arrangement offered by most funding sources.

Actions

1. Assess the long-term viability of skiing activities on the Wallamba River, due to high numbers of user's, amount of breaches observed and the widespread impact on the river.

2. Carry out large-scale bank protection works in the reach from ARL 6km (end of Manns Road) to ARL 14km (River Inn), to rehabilitate eroded riverbanks, if skiing is the long-term usage option for river.

3. Skiing activities be excluded from ARL 14km (River Inn/Cattle Crossing) upstream to 8 knot limit at 21.5km. This is due to the ecological importance of the vegetation and the extremely high cost of bank protection works in this reach (and the need for massive protection works downstream to secure skiing access).

4. Skiing activities be excluded from ARL 4.6km (end of no ski zone) upstream to ARL 6km (end of Manns Road). This is due to the extremely high cost of bank protection works in this reach (and the need for massive protection works upstream to secure skiing access).

5. Waterways and GLC to investigate the feasibility of licence/levy scheme that sees skiers contributing directly to the rehabilitation of the waterway. Monies could also be utilised to provide better facilities, eg boat ramps, picnic areas, signage, education programs and additional Waterways Officer(s).

6. Waterways to introduce a code of conduct that promotes best management boating principles.

7. GLC and DIPNR to maintain funding assistance for landholders that are interested in riparian zone management and other natural resource management issues.

8. GLC and DIPNR to liase with Department of Lands NSW to introduce best management farming practices that aim to manage and improve natural values of foreshore reserves. Consider the benefits of Crown Land swaps &/or conservation agreements that focus on implementing key findings of *Independent Inquiry into Coastal Lakes.*

9. GLC and Waterways to develop a Boating Management Plan for the entire Wallis Lake System that focuses on the protection of the Lakes unique values, as well as providing opportunities for all user groups.

10. Landholders to seek funding and technical assistance to implement erosion control works where necessary. NB, Any works that involve excavation may require a permit under the *Rivers and Foreshore Improvement Act* and/or permission from the Department of Lands.

11. Where recommended, landholders to reduce the impact of stock on the riparian zone by fencing and providing alternative shade. Revegetate unstable riverbanks with native indigenous trees, shrubs and grasses (see appendix 8.4). Seek financial support with the assistance of the Landcare Coordinator.

12. Landholders to seek assistance from programs such as Green Corps in implementation of creek management projects. Contact the local Landcare Coordinator or DIPNR Natural Resource Officer (Riverine) for further information.

13. GLC to promote projects associated with the Rivercare plan through the local television, radio, print media, and signage. Ensure funding applications allow for costs associated with purchase of appropriate signage and pamphlets etc.

4.1.2 Stock damage to riparian areas

The effects of stock on the riverbanks were apparent whilst inspecting the river. Overall there is very limited management of stock to the riparian zone. The impacts of stock on riparian ecosystems is variable depending on the type of grazing system used by individual landholders, and the environmental conditions of the riparian zone. Generally, the impacts caused by stock are:

- Grazing and trampling of native vegetation which depletes the banks of reinforcing vegetation, therefore making the banks more prone to erosion;
- Grazing of native vegetation can prevent young vegetation from growing. Grazing interrupts the replenishment of new vegetation, and impedes the replacement of mature vegetation as it dies off from old age and disease;
- Stock movement can directly expose bank material to erosion, compacting soil which reduces infiltration, root growth and overall plant production;
- Selective grazing can diminish the overall diversity of plant species in an area, and provide more favourable conditions for weeds that prefer degraded areas; &
- Concentration of nutrients derived from cattle dung contributes excessive nutrients to waterways.

Figure 15: Example of stock damage to bank, soil, and vegetation regrowth.
Note how cattle utilise this area for shade. By doing so they contribute excessive nutrient to the river and Lake System.

Figure 16: Examples of stock damage to Swamp Oaks and to Mangroves.

Note: These two native riparian species provide the first line of defence in reducing flood flow velocity and wave attack (wind and boat generated), and are they are integral to the early phases of "River Recovery".

Fencing

Fencing is recognised as an important tool for the long-term protection of rivers, particularly when trying to establish vegetation on bare banks. It is up to individual landholders to determine the most suitable type of fencing along a river or creek (eg. permanent fencing, temporary fencing, total exclusion or controlled grazing). Grazing of fenced areas can be a management tool, especially in the control of exotic weed species.

The type and location of fencing that best suits your needs will depend on your type of stock, when and how much you want to use the riparian land, the size and shape of the stream channel, flood frequency and size of flood peak.

Following are some questions that need to be answered when planning your fence.

Is the riverbank vertical? The absolute minimum distance of a fence from a vertical bank must allow for both erosion that may occur prior to stabilisation of the erosion, as well as the natural laying back of the bank to a stable angle (angle of natural repose). The angle of natural repose can be judged from adjacent banks or from banks of similar material and of similar height that have been stable for some time. As a general rule of thumb, the angle of natural repose is approximately 45^0. Therefore a vertical bank 2m high will erode 2m back, if the erosion process is stopped. Putting the fence within 2m means you will more than likely have to move the fence in time.

How best does the fence fit into farm or paddock management? Rather than totally excluding stock, many fences simply allow better management of stock along rivers. Selective grazing (sometimes called crash or pulse grazing) of narrow paddocks along rivers is a management practice that can maximise production while still providing adequate protection.

Will the fence be lost during floods? Loss of high quality permanent fencing during floods is not only a cost, but also a hazard. If flood patterns are taken into account when locating strainer posts etc., both local problems and fencing replacement costs can be reduced. It is far cheaper to replace short sections of "sacrificial" fencing than whole fence lines.

What type of fence will best suit the purpose of river protection? A permanent stock-proof fence constructed out of flood level and of a width sufficient to include a wide variety of vegetation is an ideal, however, is not always appropriate. Due to factors such as flood levels or paddock width restriction by property boundaries, a permanent stock-proof fence may not be an option. Use of an electric fence can restrict stock access and allow vegetation establishment and maintenance.

What form of access along the riverbank will be required? A river corridor that has been excluded from farming practices such as ploughing, grazing and broadscale chemical weed control may become an area where weeds and noxious animals prosper. Due to efficiency of transport during floods, weeds are a particular problem of river corridors. The need for vehicular access to allow management of the fenced river must be considered when planning fence location.

How much land will be lost? Land fenced into a river corridor is land lost to cultivation and to long-term grazing, but remains an asset that can be utilised for short term grazing. A riverbank eroded during flooding is an asset permanently lost.

General Principles for Grazing Riparian Land

It is now widely recognised that heavy stock grazing pressure in riparian areas (eg river banks) can lead to many environmental problems (see attached Land & Water Australia fact sheet no. 6 *Managing stock*). While some managed stock access to these areas may be required for such things as stock access to shade or to occasionally graze to reduce fuel/weed loads, permanent access often leads to a decline in riparian vegetation. It is the intent of these principles to allow for the occasional 'pulse' or 'crash' grazing in riparian land, while at the same time encouraging natural regeneration of riparian vegetation to assist in future bank stability.

In many situations, limiting stock access to riparian areas may not only assist native vegetation regenerate but will lead to a proliferation of weeds. While various weed species are well established along many of our stream systems and now form an integral part of the riparian vegetation community, others require removal by law. Grazing pressure should be used to control weeds where possible, with the aim being to strike a balance between weed suppression without impacting too severely on native vegetation.

The level of grazing pressure a riparian area can withstand without suffering undue harm is highly site-specific and will be influenced by such things as:

- The vegetation community concerned, as well as its extent and condition;
- What grazing animals are to be allowed access;
- Time of year eg riparian areas should not be grazed when seedlings are establishing; &
- What pasture is available.

Generally speaking, a carefully grazed riparian area will show minimal stock damage and have a healthy understorey that includes young saplings of the dominant tree species that are present at the site.

Land & Water Australia is a statutory research and development corporation within the Commonwealth Agriculture, Fisheries and Forestry portfolio. This organisation, through its *National Riparian Lands Research and Development Program* and information shared through the *National Rivers Consortium*, provides extensive information on riparian land management. Further information about these programs can be found at www.rivers.gov.au or through DIPNR.

Pulse Grazing - (An explanation)

Pulse grazing is a site specific grazing regime that has the primary aim of maintaining or enhancing native vegetation through the careful manipulation and management of stock grazing pressure. This is usually achieved by allowing stock into a small area for brief periods of time to allow grazing and possibly to control weeds. The intent of 'pulse' grazing in the riparian zone is to encourage and maintain the riparian zone as a buffer between the paddocks and the river.

<u>Actions</u>

1. Landholders to undertake stock management at sites as recommended. Advice is available from the Landcare Coordinator and DIPNR as required. Funding sources available to carry out stock control along streams, including riverbank fencing are identified in ***Appendix 8.5***

2. Landholders to incorporate stream management proposals identified in the Rivercare Plan into individual property plans. If landholders do not have a Property Plan, look at developing one with the assistance provided by the following programs:

- "Prograze" Run by NSW Dept. of Agriculture mainly focused at beef production (pasture management and animal health). Mac Elliott or Peter Beale at the Taree office on (02) 6552 7299
- "Profit Through Better Farm Management" Holistic farming training course run by Bruce Ward of Holistic Results. Phone (02) 6721 1105. Web site: www.holisticresults.com.au
- "Farmbiz" Financial assistance scheme for farm business training. (02) 6391 3000. Web site: www.raa.nsw.gov.au
- General Farm and Agricultural Advisory Services Resource Consulting Services Pty Ltd. Coffs Harbour (02) 6658 0775

Note: These are a sample of the options for farm planning available in the Lower North Coast area. Their inclusion on this list does not infer any particular recommendation. The list was chosen for its representative spread. There are many other natural resource/farm management consultancies available through the Yellow Pages or web based searches.

3. GLC to promote works associated with the Rivercare plan through the local television, radio, print media, and signage if appropriate. Also ensure funding predictions allow for costs associated with purchase of appropriate signage and pamphlets etc.

4.1.3 Foreshore Reserve Management

The Department of Lands is the primary administrator for Crown land tenures and unallocated Crown lands in NSW. The department administers an area of approximately 12.7 million hectares. It is responsible for the professional management of some 72,600 licences and permits state wide, along with 14,800 leases. The department is also responsible for the administration of the Crown reserve system – Crown land set aside for public purposes eg access, public recreation, boat ramps, wharves etc. Crown roads are also administered by the department and most tidal waterways also come under their jurisdiction.

The land management responsibilities for Crown land typically rest with the lessee or permit holder. Alternatively, the management of public reserves typically rests with the local council.

The foreshore of the Wallamba River is predominantly Crown land. Approximately 75 % of the foreshore (42km out of 56km both banks) is either Crown road or Crown reserve (mostly for access). A map of Crown land status is attached. Investigation of Crown land tenure records has revealed that substantial portions of this land are occupied without authority. In many cases, adjoining holders do not recognise the Crown land status.

Notwithstanding the majority of the foreshore is grazed and there are widespread impacts associated with this practice (see 4.1.2). Uncontrolled grazing pressure is a contributing factor to degradation of the riparian zone, including erosion and impact on sensitive vegetation types. Given the environmental and economic significance of Wallis Lake, it is important that best management practices are employed.

The principle recommendation of the Healthy Rivers Commission: Independent Inquiry into Coastal Lakes (2002) is that the government adopts a new comprehensive and more effective set of over arching arrangements for the management of coastal lakes and their catchments. Given the predominance of Crown land frontage there is an added corporate responsibility by government to assert and facilitate best management practice ie aim to “manage state owned lands for the environmental, economic and social benefits for the people of NSW”.

The broad strategy necessary for best management practice along the foreshore relevant to administration and management of the affected Crown lands include;

- Review the allocation and management of Crown lands to ensure protection of ecologically sensitive areas and public access where compatible.
- Review and amend Crown tenures over foreshore lands to ensure the terms and conditions work to compliment foreshore management and holders comply with such terms and conditions.
- Implement projects to rehabilitate and protect degraded sections of the foreshore, particularly public assets;
- Encourage riparian fencing so that stock pressure can be controlled using pulse grazing; and
- Manage commercial and recreational users of the river in ways that protect ecological health and to ensure compatibility between different uses.

Great Lakes Council has recently initiated a program to implement the Wallis Lake Catchment Management Plan. Funding from Commonwealth, State and local government sources is available to assist the planning and implementation of works on the ground.

Actions

1. Department of Lands and Great Lakes Council to develop and implement a communication strategy to ensure all landholders along the foreshore are aware of the issues identified in this plan and proposals to improve foreshore management;

2. Department of Lands to update Crown tenure records to record voluntary agreements between landholders and other agencies, and expenditure of public funds, for land rehabilitation projects and other works to improve the condition of the foreshore. Consider amending the terms and conditions of tenures upon transfer to ensure any works implemented with public funds, or other negotiated agreements, are protected by successive holders;

3. GLC and DIPNR to investigate options to facilitate and encourage holders of both Crown tenures and freehold lands to fence the foreshore and manage grazing pressure to minimise negative impacts;

4. Investigate and review land status, including Crown tenures, along the foreshore to ensure protection of ecologically sensitive areas and to protect public access where compatible with foreshore management

4.1.4 Lack of a wide and diverse native riparian vegetative buffer

Although there are some areas of good riparian vegetation cover along certain parts of the Wallamba River, large expanses of river bank are primarily grass covered, with isolated trees and a depleted mix of natives with weeds such as lantana and camphor laurels. It is essential to have a buffer zone of riparian vegetation at least 10 metres back from the top of the bank to ensure stability of the bank. Without this the bank will always be susceptible to erosion.

Apart from the stability function of vegetation, the health of the river is directly related to the extent and diversity of native riparian vegetation, and the benefits of a good buffer of riparian vegetation are many and diverse, for agriculture as well as ecological processes. They provide such things as:

- sediment and nutrient buffers;
- wind breaks;
- climate moderation;
- weed and pest control;
- refuge for stock and wildlife during droughts and severe weather;
- protection of alluvial flats against erosion during flood events;
- moderation of groundwater stores and flows;

- Resilience or capacity to recover after erosion;
- Provide Ecotourism;
- Financial asset - adding value to the property; &
- Seed source.

For more information see **appendix 8.5**.

Figure 17: An example of well structured riparian vegetation.
Note the fringing line of mangroves and adjacent bank vegetation, both providing terrestrial and aquatic habitat, as well as providing bank stability.

Actions

1. Landholders to implement revegetation strategy or encourage regeneration of riverbank in areas identified on the Rivercare Plan. Seek technical assistance from the DIPNR Natural Resource Officer (Riverine) and the Landcare Coordinator for funding advice. See **appendix 8.4** for suitable species and other useful planting tips.

2. GLC and DIPNR to raise awareness within the community of the importance of riparian vegetation in stabilising stream banks, providing fish habitat and filtering nutrients by holding field days, producing pamphlets, etc.

3. Landholders to identify areas that lack vegetation on individual property plans. Prioritise areas for management. Most degraded sites should get highest priority. If landholders do not have a Property Plan, look at developing one with the assistance provided by the following programs:

- "Prograze" Run by NSW Dept. of Agriculture mainly focused at beef production (pasture management and animal health). Mac Elliott or Peter Beale at the Taree office on (02) 6552 7299
- "Profit Through Better Farm Management" Holistic farming training course run by Bruce Ward of Holistic Results. Phone (02) 6721 1105. Web site: www.holisticresults.com.au
- "Farmbiz" Financial assistance scheme for farm business training. (02) 6391 3000. Web site: www.raa.nsw.gov.au
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Note: These are a sample of the options for farm planning available in the Lower North Coast area. Their inclusion on this list does not infer any particular recommendation. The list was chosen for its representative spread. There are many other natural resource/farm management consultancies available through the Yellow Pages or web based searches.

4. GLC to promote works associated with the Rivercare plan through the local television, radio, print media, and signage if appropriate. Also ensure funding predictions allow for costs associated with purchase of appropriate signage and pamphlets etc.

4.1.5 Water Quality

Water quality has been identified as a major concern for landholders in the Wallis Lake catchment. Water quality is primarily the net result of the impact of all land-based activities occurring within the catchment. The sources of pollution or processes responsible for deteriorating water quality are extremely complex and may include the combination of nutrient inputs from soil erosion, septics, fertiliser runoff, roadside runoff, natural geology and groundwater, native birds and animals, livestock, and existing sediments.

Water is an important resource and good water quality is a high priority for the community and the environment. Water in the Wallis Catchment and its tributaries is used for stock watering, and domestic purposes. Extensive agricultural, recreational and fisheries industries downstream in the Wallis Lake estuary rely on good water quality to survive.

With the state of water quality in Wallis Lake contributing to the Hepatitis A outbreak of 1997 in Wallis Lake oysters, GLC is encouraging all landholders to improve water quality in their catchment, so that the water quality meets the desired criteria for a healthy, productive and sustainable catchment for future generations.

Figure 18: Duck weed (*Arozolla spp*.) in Wallamba River in March 2003.

Water Quality in the lower (tidal) Wallamba river is influenced by the quality of water flowing from the freshwater rivers and streams in the upper Wallamba catchment, local land use and run-off and estuary circulation and processes. The estuary circulation characteristics have a particular importance for defining the water quality of the Lower Wallamba. It is estimated that the time taken for full tidal exchange in the Lower Wallamba (tidal section) in the upper reaches around Nabiac may be greater than two months. Towards the mouth of the Wallamba (upstream) from Tuncurry the time for full tidal exchange is estimated to take around two weeks. A consequence of these long flushing times (under normal flow conditions) is that the lower Wallamba river system will act as a depositional area for delivery of nutrients and sediment from the catchment. These characteristics have the potential to influence water quality characteristics in the long term, and hence it will be important to manage the delivery (or movement of nutrients and sediments) into the lower Wallamba. (See section 3.2.) The management of nutrient loads entering this area is extremely important, with the fish kill episode in April 2003 is testimony to the problems associated with periodic water quality problems.

There has only been limited monitoring of water quality in the lower reaches of the Wallamba river. Research is currently been undertaken into the fate and movement of nutrients in the estuary system, with this project designed to develop better understand the water quality characteristics of the estuarine Wallamba River. The Department of Infrastructure, Planning and Natural Resources has an ongoing monitoring program sampling the freshwater Wallamba River at Clarkson's Crossing (near Nabiac) which provides summary data describing the quality of water delivered to the estuarine Lower Wallamba River system.

Summary (median) results from monitoring Jan 1999 – June 2003 comparing the water quality of the Freshwater Wallamba River with that of the neighbouring Wang Wauk and Coolongolook Rivers are shown in the table below.

Table 1: Comparison median results the three freshwater "end of system" river monitoring sites in the Wallis Lake catchment. Data from Jan 1999 – June 2003.

Parameter (Median) / Site	Faecal Coliforms (CFU /100mls)	Electrical Conductivity (µS/cm)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Turbidity (NTU)
Coolongolook	97	324	0.59	0.034	14.5
Wang Wauk	50	515	0.54	0.046	9.1
Wallamba	35	724	0.60	0.065	6.8

Data source DIPNR 2003.
Note: Guidelines: ANZECC (2001) guidelines for primary contact recreation ie. Swimming, indicate the median Faecal Coliforms count for the swimming season should be below 150 faecal coliform units/ 100ml. (The above data shows that the three river systems comply with guidelines.)

It can be seen that the freshwater Wallamba River system has higher median total phosphorus levels than the other river systems in the Wallis Lake Catchment, where as assessed total nitrogen levels are relatively similar for all three rivers. The median higher electrical conductivity values recorded for the Wallamba River system is as a result of the underlying geology (marine sediments) present in the upper reaches of the catchment. The turbidity of all three river systems is generally low with the higher salinities of the Wallamba river system possibly influencing he lower turbidity values recorded.

An excellent overview on the importance and management of water quality can be found in ***Appendix 7.5*** Riparian Management pamphlet number 3 "Water Quality".

Actions

1. Landholders to implement all works identified on the Rivercare Plan that may be potential sources of nutrient pollution to Wallamba River. This is likely to greatly assist the improvement of water quality in the main watercourses. Identified works include restoration of erosion sites, stock control where watercourses are utilised as laneways or regular stock shade sites, or where wetlands are heavily modified and over-grazed.

2. DIPNR to conduct Rivercare planning and other natural resource management plans in the upper catchment to engage landholders in the management of water quality entering the Lake system.

3. Field days should continue to be held to inform the wider community of the advantages of good water quality throughout the catchment and for all water users. Liaise with Great Lakes Council, NSW Fisheries, NSW Agriculture, and DIPNR for guest speakers. Issues covered could include:

- the status of water quality in Wallamba River;
- how to improve/maintain water quality throughout the catchment;
- the importance of quality riparian vegetation and wetlands as the 'kidneys' of the lake;
- the importance of good water quality for livestock production, commercial fishing and oyster industries, native ecosystems, and human health;

4. GLC to promote best management practices of fertilisers, to limit nutrient levels and potential for algal blooms. Promote correct fertiliser use throughout the catchment by holding field days for fertiliser users. Liaise with the District Agronomist and local fertiliser representatives for assistance in organising guest speaker's etc. Carry out soil testing with the assistance of the District Agronomist to analyse the appropriate fertiliser requirements on all land to be fertilised in the catchment.

5. GLC to promote water quality management projects through the local television, radio, print media, and signage if appropriate. Also ensure funding predictions allow for costs associated with purchase of appropriate signage and pamphlets etc.

4.1.6 Weeds

Weeds degrade agricultural areas and natural ecosystems by replacing desirable species within pastoral and native habitats.

Invasive weeds cause a number of environmental problems. They can:

- degrade natural habitats for native animals;
- replace important native plant species that provide structural integrity, and resistance to stream energy;
- reduce the productive capacity of land;
- add to farm costs by requiring removal/remedial action to avoid further loss in farm production;
- impact on human and livestock health through poisoning/injury;

<u>Problem weeds in the Riparian Zone</u>

Weeds can displace or out compete native species, where these native riparian species normally provide excellent structural stability, and resistance to stream energy. Where weeds have replaced these natives, erosion can be accelerated, as weeds in most cases haven't evolved to withstand floods. Where dense weed infestations occur it can be expected that the risk of bank erosion is much greater that a bank vegetated with endemic riparian vegetation.

Figure 19: Example of Madeira Vine Infestation.

Note: Madeira or Potato Vine (*Anredera cordifolia*), as shown above, poses a major problem by smothering native vegetation and preventing the establishment of valuable riparian vegetation.

Weeds on the Wallamba River

Various woody and herbaceous weeds were identified along the Wallamba River and adjacent land covered by the Rivercare Plan. The main weeds of concern are;

- Camphor Laurels;
- Madeira Vine;
- Buddleja sp.;
- Lantana; and
- Asparagus fern.

Distribution of the specific species of weeds varies, with the majority of the weed species identified occurring only sporadically throughout the plan area. The following five weed species need management action to limit their spread and impacts on the surrounding environment;

1. Camphor laurels are becoming a major concern in the Failford/Darawank area, as well as around Nabiac, with many large seed bearing trees now well established. Many young trees can be seen invading the surrounding bushland, as well as the riparian zone and fence lines alike. Camphor laurels are much more prone to undercutting and erosion than a riverbank supporting a diverse range of native vegetation. Camphor laurels should be gradually replaced with endemic native vegetation.

2. Madeira vine is located as isolated patches. Given the potential threat of this vine, and the high cost of removing large infestations (eg, Wingham Brush), it is recommended that it be eradicated now and not allowed to spread any further. Madeira vine can invade established bushland and can destroy/smother healthy trees, greatly reducing the ecological integrity of the forest community, and riverbank stability.

3. Buddleja is located only as isolated infestations in the lower estuary. It forms a massive dense thicket that is almost impenetrable. While these dense infestations do offer some bank support, it is much more prone to undercutting than mature riparian vegetation. Care must be exercised when removing this species as it can cause throat allergies. Also, Buddleja can reproduce from fragments/sections disturbed during removal, so care should be taken to monitor sites post control.

4. Lantana occurs in dense infestations near Nabiac and occurs throughout most of the remaining Rivercare Plan area. Whilst Lantana is dominating some sections of the riparian zone, it is providing some bank support. The removal of Lantana can be a major undertaking and past experiences have demonstrated that follow-up maintenance is usually required. Any removal also requires replacement with native species to protect the bank. Therefore broad scale removal is hard to justify, with the removal in a mosaic pattern more desirable.

5. Asparagus fern is present in isolated patches throughout the lower Rivercare Plan area. Of special concern was the Tuncurry side of the Wallamba Broadwater (adjacent Tuncurry Lakeside Village). This weed has the potential to severely modify ecological communities. It is an aggressive groundcover that can displace regenerating native vegetation, by actively out competing and smothering seedlings.

For the purpose of this Rivercare Plan, management priority has been given to those weeds that pose a serious threat to the structural integrity of the river and ecological health of the riparian zone. Priority is given to weeds where the ratio between environmental outcomes and resource expenditure is favourable, or where landholders are particularly motivated.

There are many vectors for transportation and introduction of weeds, but in order for weeds to get established they generally need disturbed ground and good sunlight. Consequently relatively undisturbed areas with a good remnant canopy cover are relatively weed free.

Weed plants are characterised by their aggressive colonisation of susceptible areas. They generally have the ability to reproduce rapidly and what may start as one or two plants may quickly turn into an infestation.

Some weeds such as Camphor Laurel are believed to exude chemicals, which inhibit the regeneration of other plants, eventually forming stands of almost single species (Joseph, 1995).

Weed plants thrive in disturbed areas and most species are dependent on full sunlight. Weeds are dispersed by wind, water and birds. To manage weeds effectively we must look at the ecology of each individual species.

Weed species should be controlled selectively to maintain the valuable functions of the native stream vegetation. Selective application of approved herbicides, manual removal, or sometimes-biological methods can be used.

'Pulse grazing' can be used to control some species. The timing, intensity and duration of grazing should be monitored to determine the most appropriate strategy for controlling weeds while allowing natural regeneration of native stream plants. For a definition of 'Pulse grazing' see page 36.

Refer to the "Weed Profile Fact sheets" ***Appendix 8.11*** and ***8.12*** for control options.

<u>Herbicide Use Near Streams</u>

When using herbicides near water, great care must be taken to avoid contamination of the water. To do so is an offence under the *Protection of the Environment Operations Act 1997*. The only herbicides that should be used near streams are Roundup Bi-active and equivalents.

Always seek advice from NSW Agriculture or Great Lakes Council Weed Officer as to which herbicides are registered for use on particular weeds, and which method of herbicide application is most appropriate to minimise impacts to adjacent watercourses and native riparian vegetation.

Generally, the preferred method for controlling regrowth or weeds near streams is the "cut and paint (poison)" method. There are two reasons for this. Firstly, to minimise the chance of polluting the stream. Secondly, when controlling weeds on banks, to avoid damage to other vegetation and to prevent bank instability. Refer to the ***Appendix 8.12*** for further information on weed control and Best Management Practice.

Spraying is only recommended for growth less than one metre high. Spraying must be carried out in calm conditions with the spray directed away from the water. There must be no spraying within two meters of the water level. Any town water supply authority should be notified prior to spraying herbicides near streams. See ***Appendix 8.10*** for Draft guidelines for use of Herbicides near streams.

For more detailed information on weeds see the ***Appendix 8.11***

<u>Weed Management Options</u>

It is important to consider whether or not a weed species is actually deteriorating the ecological health of the riparian zone. This can be quite obvious at times for example where dense monocultures exist. On the other hand, a mix of weeds and native plants may provide food and shelter for a range of animal species where the weeds are not particularly detrimental. In order to maintain the ecological health of the riparian zone those weeds that pose a serious threat to the overall biological health of the river, have a higher priority for management intervention.

For practical purposes Weed Management Options applicable to Rivercare Plans are based on three levels of intervention to give better direction to landholders when deciding where, when, and how they should tackle the weed problems in their area. These are:

Option 1: CONTINUALLY SUPPRESS AND DESTROY (aiming for eradication):

This option would apply where:

- A weed exists in an isolated location and threatens high quality vegetation. The cost of eradication should be weighed against the level of threat ie the conservation value of downstream reach and/or the variation of threat from species to species. Eg isolated outbreaks of Madeira Vine that could be controlled now, at minimal cost, given the potential for that weed to spread and degrade riparian vegetation;

- Where a landholder is prepared to implement this option, and is willing to undergo this weed control with full knowledge of the effort and resources required to implement this strategy and the requirements for ongoing maintenance;

- Where costs are viable and the results are likely to be achieved eg volunteer labour for larger infestations available. (Seed source consideration); and

- Where a landholder is required to continually control and suppress the weed in concern in accordance with relevant legislation. Eg the NSW Noxious Weeds Act 1993.

Option 2: MINIMISE DISTRIBUTION
(Containment of existing weed occurrences and monitoring and maintenance of intact non-infested areas)

This option would apply where:

- An acceptable mix of weeds and natives coexist and the weeds actually play a functional role in the provision of habitat and food (eg lantana fruit);

- Current weed infestation is beyond the scope of landholder to undertake, but landholder is prepared to control new outbreaks;

- Weeds provide bank stability (eg Camphor laurels at waters edge. Removal techniques may involve lopping to reduce seed production, but would not involve poisoning, ie maintain active root zone for bank stability. Regrowth could be poisoned once planting of native species have started to mature); &

- Where some traditional weed control methods eg herbicide spraying are impracticable or uneconomical.

Option 3: DO NOTHING

This option would apply where:

- a particular weed is limited in density and location, and is unlikely to impact on the ecological health of the riparian zone;

- Where the weed is acting as a buffer on the margin of good vegetation and it’s removal may cause more problems. Eg. Lantana is ‘sealing’ edge of moist forest and its removal may cause a reduction of humidity (that most natives need), and an increase in light (= more weeds); and

- Where some traditional weed control methods eg herbicide spraying are impracticable and/or uneconomical (eg, steep banks).

<u>Declared Weeds</u>

Declared weeds under the *Noxious Weeds Act 1993*, are categorised as follows:

W1 weeds: These weeds are the most significant and must be fully and continuously suppressed and destroyed. The presence of these weeds on land or in water must be notified to the local council.

W2 weeds: These weeds must be fully and continuously suppressed and destroyed.

W3 weeds: These weeds must be prevented from spreading and have their numbers and distribution reduced.

W4 weeds: ***4f*** these weeds must not be sold, propagated, or knowingly distributed. Any biological control or other control program directed by a local control authority (local council) must be implemented.

4g these weeds must not be sold, propagated or knowingly distributed.

Table 2: Declared weeds in the Great Lakes Council Local Government Area.

Common name	Scientific name	Category
African boxthorn	*Lycium ferocissimum*	W2
Alligator weed	*Alternanthera philoxeroides*	W1
Bathurst Noogoora Californian Cockle burrs	*Xanthium spp.*	W3
Black knapweed	*Centaurea nigra*	W1
Blackberry	*Rubus fruticosus (agg. spp.)*	W3
Broomrape	*Orobanche spp.*	W1
Cabomba	*Cabomba spp.*	W4g
Columbus grass	*Sorghum x almum*	W2
Crofton weed	*Ageratina adenophora*	W3
Dodder	*Cuscuta campestris*	W2
Giant Parramatta grass	*Sporobolus fertilis syn. Sporobolus indicus var. m*	W2
Giant rat's tail grass	*Sporobolus pyramidalis*	W2
Green cestrum	*Cestrum parqui*	W3
Groundsel bush	*Baccharis halimifolia*	W2
Harrisia cactus	*Harrisia spp.*	W4f
Hawkweed	*Hieracium spp.*	W1
Horsetail	*Equisetum spp.*	W1
Johnson grass	*Sorghum halepense*	W2
Karroo thorn	*Acacia karroo*	W1
Kochia	*Kochia scoparia*	W1
Lagarosiphon	*Lagarosiphon major*	W1
Mexican feather grass	*Nassella tenuissima syn Stipa tenuissima*	W1
Miconia	*Miconia spp.*	W1
Mistflower	*Ageratina riparia*	W3
Mother-of-millions	*Bryophyllum delagoense*	W2
Nodding thistle	*Carduus nutans*	W2
Pampas grass	*Cortaderia spp.*	W2
Parthenium weed	*Parthenium hysterophorus*	W1
Paterson's curse, Vipers Italian bugloss	*Echium spp.*	W3
Prickly pears	*Opuntia spp.*	W4f
Rhus tree	*Toxicodendron succedaneum*	W2
Salvinia	*Salvinia molesta*	W2
Scotch English broom	*Cytisus scoparius*	W2
Senegal tea plant	*Gymnocoronis spilanthoides*	W1
Serrated tussock	*Nassella trichotoma*	W2
Siam weed	*Chromolaena odorata*	W1
Spiny burrgrass	*Cenchrus incertus*	W2
Spiny burrgrass	*Cenchrus longispinus*	W2
Spotted knapweed	*Centaurea maculosa*	W1
St John's wort	*Hypericum perforatum*	W2
Tree of heaven	*Ailanthus altissima*	W3
Water hyacinth	*Eichhornia crassipes*	W2
Water lettuce	*Pistia stratiotes*	W1
Willows	*Salix spp.*	W4g

For further information about weeds or weed control, visit the www.agric.nsw.gov.au/weeds/ or send an e-mail message to weeds@agric.nsw.gov.au. Alternatively, contact Great Lakes Council on 6591 7222.

Environmental Weeds

These are weeds that are not declared noxious under the *Noxious Weeds Act 1993*, however they are detrimental to the natural environment and may also affect human health and agricultural production. As some environmental weeds may be natives or within 20 metres of the streambank of the Wallamba River, their control must be carried out in accordance with the *Native Vegetation Conservation Act 1997*.

Table 3: Environmental weeds identified along the Wallamba River.

Camphor Laurel	*Cinnamomum camphora*
Madeira Vine	*Anredera cordifolia*
Lantana (pink flowered)	*Lantana camara*
Buddleja	*Buddleja madagascariensis*
Asparagus Fern	*Protasparagus aethiopicus*
Small Leaf Privet	*Lingustrum sinense*
Morning Glory	*Ipomoea indica*
Bamboo	*Arundinaria sp.*
Wild Passion(fruit) Flower	*Passiflora subpeltata*
Mickey Mouse Bush	*Ochna serrulata*
Cassia	*Senna pendula*
Castor Oil Plant	*Ricinus communis*
Wild Tobacco Bush	*Solanum mauritianum*
Wandering Jew	*Tradescantia fluminensis*
Pine Tree	*Pinus spp. (radiata)*
Coral Tree	*Erythrina X sykesii*
Tall Fleabane	*Conyza albida*
Fireweed	*Senecio madagascariensis*
Prickly Pear	*Opunita spp.*
Stinking Roger	*Tagetes minuta*
Purple Top	*Verbena bonariensis*

Actions

1. GLC and NSW government agencies to assist in the education of landholders throughout the area in the identification and the problems associated with weeds, their obligations and strategies for control. Continue to liaise with the local Noxious Weeds Officer about organising distribution of relevant pamphlets on weed control (preferably with pictures) and holding field days.

2. GLC to liaise with the local Landcare Coordinator and/or DIPNR to explore opportunities for work team(s) (eg, Green Corps) to assist the community in addressing priority areas of infestations of Madeira Vine as identified on the Rivercare Plan.

3. GLC to seek funding to establishment Camphor laurel replacement program. This would entail gradually replacing large seed producing Camphor laurel trees, with native trees (advanced & tubestock) suitable for shade.

4. Landholders to continue to manage individual properties to control weed species and encourage native vegetation along riverbanks for long term control.

5. Landholders to mark environmental and noxious weeds on individual property plans. Prioritise areas of weed infestation for control. Most environmentally sensitive sites should get highest priority (eg. outside bends of streams, and high conservation native vegetation. If landholders do not have a Property Plan, look at developing one with the assistance provided by the following programs:

- “Prograze” Run by NSW Dept. of Agriculture mainly focused at beef production (pasture management and animal health). Mac Elliott or Peter Beale at the Taree office on (02) 6552 7299

- "Profit Through Better Farm Management" Holistic farming training course run by Bruce Ward of Holistic Results. Phone (02) 6721 1105. Web site: www.holisticresults.com.au
- "Farmbiz" Financial assistance scheme for farm business training. (02) 6391 3000. Web site: www.raa.nsw.gov.au

Note: These are a sample of the options for farm planning available in the Lower North Coast area. Their inclusion on this list does not infer any particular recommendation. The list was chosen for its representative spread. There are many other natural resource/farm management consultancies available through the Yellow Pages or web based searches.

4.1.7 Acid Sulphate Soils

Acid sulphate soils (ASS) are soils that contain iron sulphides which, when exposed to oxygen, produce sulphuric acid that has the potential to impact upon the health of terrestrial and aquatic ecology. According to the Acid Sulfate Soil Manual produced by the NSW Government, every estuary and embayment along the NSW coast has acid sulphate soils. If left undisturbed ASS do not pose a problem to the surrounding environment. Unfortunately disturbance to these soils has taken place along the lower floodplains of Wallamba River with significant areas of land being subject to high concentrations of acid. The drainage networks constructed to make the back swamps more farm "friendly' are linked to the Wallamba River, whereby the acid runoff has the potential to cause adverse effects on aquatic health. Impacts such as fish disease, oyster mortality and the release of heavy metals can be linked to the drainage of ASS's (Sammut et al 1996). The main area of concern in the Lower Wallamba is Darawank Creek, Bungwahl Creek and West Swamp (WLCMP).

Figure 20: An acid sulphate plume entering the Wallamba River from Darawank Creek.

The most common activities that disturb acid sulphate soils are:

- agricultural activities that involve land drainage;
- flood management drainage works;
- urban development; &
- extractive industries – soil extraction from the river or floodplain.

How do you know if you have acid sulphate soils on your property? Mapping of soils in the Wallamba River estuary was undertaken in 1998. These maps (Appendix 8.3) outline the soil types present and the likelihood of them producing sulphuric acid if disturbed. You will notice at first glance that the majority of the creek banks and adjacent floodplains have high risk Acid Sulphate Soils. If you determine that you do have acid sulphate soil on your property then the best way to mitigate impacts is to avoid exposure to oxygen by not digging up the soil or lowering the watertable.

The Great Lakes Council requires development approval for works undertaken in areas that have the potential to produce acid soil conditions. The definition of "works" as outlined in the GLC LEP includes:

- any disturbance of more than one tonne of soil (such as occurs in carrying out agriculture, the construction of drains, extractive industries, dredging, the construction of artificial waterbodies or flood mitigation works), or

- any other works that are likely to lower the watertable.

Some of the more tell tale signs of the effects of acid sulphate soils include:

- areas of scalded soil devoid of vegetation;
- crystal clear water in low lying effected areas indicative of acid leachate;
- rusty iron flocculate or iron staining on soil in the bottom of drainage lines; &
- damage to engineering works; eg, bridge (concrete) footings, floodgates and jetties.

Actions

If you think that you may have an area of land affected by acid sulphate due to prior disturbance and would like to undertake works to ameliorate the impacts, contact DIPNR or GLC. They will be able to provide advice in the selection of appropriate mitigation strategies (see ASS map in **Appendix 8.3**).

4.1.8 Snags or Large Woody Debris (LWD)

LWD is important to river bed and bank stability, and also provides a range of essential flow conditions and habitat for aquatic plants and animals including fish. LWD provide a substrate for algae and other microscopic plants to grow that provides food and habitat for a variety of aquatic animals. They also trap leaf litter that acts as a hot spot of biological activity and a major source of food for aquatic life. LWD creates turbulence to help aerate the water thereby improving oxygen levels, a key factor in healthy aquatic ecosystems. LWD produce calm backwaters and shade where fish can shelter and spawn. LWD can act as a structure to deflect water flow away from the bank to reduce the rate of bank erosion, assisting in the stabilisation of sediment.

Some people are of the opinion that logs within the channel zone should be removed. However, manipulation of LWD should only occur in certain circumstances under advice from DIPNR and NSW Fisheries, where LWD is causing excessive erosion. Usually such erosion is obvious because of a lack of adjacent bank vegetation. Relocation or reorientation is the preferred management technique and is sometimes known as 'brushing'.

Figure 21: An example of log brushing adjacent Mann's Road; ARL 7.5km.

An overview on the role and management of LWD can be found in **Appendix 8.5** Fact Sheet No.7.

Actions

Always seek advice and necessary permits from the DIPNR and NSW Fisheries when considering the relocation or removal of any LWD.

4.1.9 Fish passage blockages

Fish move between habitats daily. Typically, fish habitat is a pool situation where logs and undercut banks and tree roots provide shade, still water and a variety of food. But they also move "between" habitats. Estuary Perch for example, spawn in the lowland river reaches where the young develop in the estuary nurseries; then eventually travel upstream as juveniles. Blocking fish passage between habitats will have serious implications to fish populations in the upper reaches of the river. Barrier to fish passage can be caused by a perched stream where a weir or similar feature causes a waterfall or by very shallow reaches.

The upstream limit of the River Plan is located at Clarkson's Crossing, about 200m upstream of the Pacific Highway at Nabiac. Clarkson's Crossing is one such structure. NSW Fisheries have cut slots in the concrete slab to allow for fish passage, but much like pipes, the slots tend to concentrate minor flows and make it extremely difficult for fish to swim upstream.

Figure 22: Clarkson's Crossing near Nabiac.

<u>Actions</u>

1. Wallis Lake Estuary committee to initiate a management initiative to improve fish passage on the Wallamba River.
2. GLC to consult with NSW Fisheries to obtain fishway design information. Contact persons are: Martin Angle - Fisheries Officer, Tuncurry Office (02) 6554 6078; Millie Hobson - Fish Passage Project Officer (02) 67654591; Cameron Lay – Conservation Manager (Fishway Passage) (02) 94929404.

5.0 GENERAL IMPLEMENTATION NOTES

On-Going Management

The Rivercare plan identifies site specific recommendations, and broader actions needed to improve the condition of the stream. Once the activities have been undertaken, it is necessary to carry out regular follow-up maintenance, otherwise the river may revert to an unstable state. Continual and on-going management objectives activities include:

- Monitoring of revegetation and structural works post flood, to identify maintenance needs;
- Manage stock movement and access to the river/gully etc where works have been carried out, to prevent stock damage;
- Maintenance of fencing installed for the control of stock movements and access to the river
- Follow-up removal of noxious and environmental weeds where weed clearing and/ revegetation works have been carried; and
- Maintenance of revegetation works including providing water, repair of protective bags, and controlling grass and weed growth around seedlings etc.

Permits

Works identified on the Rivercare Plan may require permission from DIPNR, Great Lakes Council, Department of Lands NSW or NSW Fisheries before works can commence. At the beginning of planning a project, advice must be sought from the relevant authorities to determine if approval is necessary and also seeking their requirements for approval to be granted. Although this plan has been endorsed, permission may still be required. It is the responsibility of the organisation/person with the management responsibility for the project to seek advice on the need to obtain any permission.

What do I need to do if I want to clear vegetation?

You will need to determine whether your clearing proposal requires development consent under the *Native Vegetation Conservation Act 1997,* and/or if other restrictions apply. Please read the fact sheet provided called Native Vegetation Management, which gives details concerning the process for clearing applications under the *Native Vegetation Conservation Act 1997* (see Appendix 8.13).

As this document was put to print, the NSW State Government is about to repeal the *Native Vegetation Conservation Act.* In its place, the *Native Vegetation Bill 2003* has been passed by parliament and will probably come into force early in 2004. For further details please visit DIPNR website on www.dipnr.gov.au or contact DIPNR (Taree Office) on 02 65522788.

What do I need if I want to undertake activities in or near rivers, lakes and wetlands?

You will need to determine whether your activity, for example excavation, building a structure or removing material from a river requires a permit under the Rivers & Foreshores Improvement Act/Water Management Act, and/or if other restrictions apply. Please read the fact sheets provided, which provide guidelines to assist in determining the need for a permit (see Appendix 8.13).

Where earthworks are required to correct eroding banks as identified on the Rivercare Plan seek technical advice from the DIPNR. A permit is required for all earthworks within 40m of the top of the bank. This includes removing or relocating gravel, the placing of fill on banks and any structures built within the channel or on the banks.

When rehabilitating eroding banks, it is important to recognise the importance of establishing dense, diverse, woody vegetation to consolidate the foreshore. Failure to do so may result in failure of the works, consequently, forward planning of revegetation before undertaking earthworks is strongly advised.

Who do I contact?

- √ Your local Department of Infrastructure, Planning and Natural Resource office at Taree, telephone 02 65522788
- √ Great Lakes Council, telephone 02 65927472

Income tax concessions

The *Income Tax Assessment Act, 1936,* and relevant sections relating to Landcare deductions, has been replaced by the *Income Tax Assessment Act*, *1997*. Deductions are still available, and in fact may be enhanced under the *Act*. A general explanation of deductions is contained in a brochure produced by the Australian Taxation Office, titled "*A Guide to Tax Incentives for Landcare*". It is recommended that individuals consult the Australian Taxation Office or a qualified accountant.

Implementation

The implementation of the management options identified on this Rivercare Plan is primarily the responsibility of the individual landholders. Assistance maybe available from GLC or DIPNR depending on resources at the time of inquiry.

Funding Assistance

There are currently various funding programs available to assist Landholders in implementing on-the-ground works, which have been identified in a management plan. GLC is currently administering a devolved grant scheme where eligible natural resource projects are funded on a 50:50 basis. For more information contact Great Lakes Council on 65927472 or your local Landcare Co-ordinator.

6.0 References and Further Reading

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7.0 Glossary and abbreviations

Abbreviations

GLC	Great Lakes Council
DIPNR	Department of Infrastructure, Planning and Natural Resource
ANZECC	Australia and New Zealand Environment and Conservation Council
NPWS	National Parks and Wildlife Service
ASS	Acid Sulphate Soils
WLCMP	Wallis Lake Catchment Management Plan

Glossary

Acid Sulphate Soils	soil containing concentrations of iron sulphide which when oxidised, combines with water to produce sulphuric acid.
Algal bloom	an event where there is rapid growth of algae species that can result in the formation of visual scums.
Alluvial	clay, silt or similar detrital material deposited by running water, eg floodplain.
Aquaculture	the cultivation of marine organisms for the purpose of human consumption.
Biodiversity	The variety of life forms: the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form. It is usually considered at three levels: genetic diversity, species diversity and ecosystem diversity.
Calcareous	resembling, containing or composed of calcium carbonate.
Catchment	an area of land identified as the boundary from where rainfall collects and runs into a common waterway.
Catchment services	the functioning of natural ecosystems provide ‘services’ that are essential for human health and survival. Eg, water filtration, maintenance of soil fertility, pollination, pest control, and maintenance of atmosphere (air).
Diatom	the common name for algae composing the class Bacillariophyceae; noted for the symmetry and sculpturing of the siliceous cell walls.
Ecological health	the environmental health of an ecosystem.
Ecosystem	a complex consisting of a community and its environment functioning as a reasonably self-sustaining ecological unit.
Endemic	being of local origin and restricted to that area in distribution.

Faecal coliform	bacteria whose natural habitat is the colon of warm blooded animals. The presence of this bacteria is considered an indicator for the presence of faecal material (dung) contamination.
Fluvial	pertaining to, or produced by the action of a river
Herbicide	chemicals designed to control/kill vegetation (weeds)
Lithology	the description of the physical character of a rock, based on colour, structure, mineral components and grain size.
Nutrient	essential element needed for growth
Nutrient load	total quantity of nutrients delivered over a defined period.
Plankton	tiny, passively floating or weakly motile aquatic plants and animals.
Pollutants	any substance likely to cause pollution
Riparian	of or occurring on the bank of a body of water, especially a river.
Salt marsh	semi-marine habitat usually found in association with mangroves, inundated only by spring (king) tides. Dominated by groundcovers.
Sea grasses	marine flowering plants that are rooted in shallow sediments.
Sinuosity	of or having a snake like or wavy appearance. In rivers the degree of sinuosity is a measure of tightness of bends or meanders.
Stratigraphy	the formation of layers in soil.
Terrestrial	belonging to or living on the land as distinct from air or water.
Topography	the configuration of the land surface, including its relief and the position of its natural and man made features.
Wetland	Areas of marsh, fern, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt.

8.0 Appendices

8.1 Catchment Processes

8.2 River Processes

8.3 Acid Sulphate Soils Map

8.4 Wallis Lake Revegetation guide

8.5 LWRCC sheet 1-11

8.6 Erosion Control in the Manning Estuary

8.7 Wallis Lake Catchment Plan Pamphlet

8.8 Ecosystem Types in Wallis Lake Catchment

8.9 Flora & fauna of Wallis Lake Catchment

8.10 Guidelines for herbicide use near stream (EPA)

8.11 Weed Profile Fact Sheets

8.12 Weed control and Best Management Practices

8.13 Native Vegetation Conservation Act FACT SHEET

8.14 Rivers and Foreshores Improvement Act FACT SHEET