Figure 7. Dredging the entrance to Tuggerah Lake.

Figure 8. Disturbance to the saltmarsh and foreshore.

2.2 Water

Managing the quality and quantity of water in and entering the estuary is important for protecting long-term estuarine health. The catchment of the estuary has undergone and will continue to undergo significant disturbance. Increasing urbanisation has changed the quality and quantity of flows into the estuary (Figures 9 & 10). The ecological function of the rivers and estuary is influenced by the quality and quantity of this water and aquatic communities may be at risk when these attributes of water are significantly altered.

The Estuary Management Study set a number of objectives for managing water to aid estuarine management (Roberts & Dickinson, 2005).

- Maintain water quality to protect healthy ecosystem function in the estuary and rivers
- Provide water quality in rivers and the estuary safe for primary human contact
- Maintain flow patterns while minimising flooding threat to life and property
- Provide adequate water for community water supply
- Minimise changes to groundwater flow/stores

Technical, Community and Business focus groups identified and prioritised the issues that make it difficult to meet these objectives. The following issues were identified by focus groups as being the most important out of a list of all water management issues (Roberts & Dickinson, 2005).

- Increased sediment and nutrient loads from existing land-uses affect water quality
- Increasing population puts an increased demand on water supply
- Increased sediment and nutrient loads from new development affect water quality
- Foreshore and streambank erosion adds sediment to waterways
- Toxic contaminants in runoff could affect aquatic ecology and human health
- Water supply and irrigation needs get priority over river flow for environmental needs

The following additional priorities were also identified as important:

- Risk of flooding
- Runoff from urban catchments and sewer overflows contain faecal coliforms
- Managing the ocean entrance
- Inadequate understanding of riverine ecological processes and riverine water quality to allow for environmental flow management

Figure 9. The quality of water in the estuary is highly dependant on catchment inputs.

Figure 10. Poor catchment management leads to changes in riverine water quality.

2.3 Vegetation

There were four main hydrological areas used to group vegetation management activities which included wetlands, estuarine, floodplain and riverine/riparian. All these vegetation communities are significant in terms of their biodiversity and the ecological processes that occur within them (Figures 11 & 12). The riverine systems flowing to the estuary have been altered to varying degrees from their natural state, whilst the loss of riparian vegetation has greatly increasing the impact that catchment activities have on riverine and estuarine systems.

The Estuary Management Study set a number of objectives for managing vegetation to aid estuarine management (Roberts & Dickinson, 2005).

- Protect, maintain & restore freshwater wetland vegetation
- Protect, maintain & restore aquatic and semi-aquatic estuarine vegetation
- Protect, maintain & restore floodplain vegetation
- Protect, maintain & restore aquatic and riparian riverine vegetation

Technical, Community and Business focus groups identified and prioritised the issues that make it difficult to meet these objectives. The following issues were identified by focus groups as being the most important out of a list of all vegetation management issues (Roberts & Dickinson, 2005).

- No existing plan for identifying, rehabilitating and managing significant foreshore habitats
- No active monitoring and management of important wetlands
- Activities in upstream catchments can change downstream wetlands
- Changes in water quality can affect aquatic and semi-aquatic vegetation
- Inadequate understanding of riverine ecological processes and riverine water quality to allow for environmental flow management
- Invasive species can degrade important habitats

Figure 11. Natural foreshore vegetation is essential for a healthy estuary.

Figure 12. Wetlands provide important functions as nutrient filters.

2.4 Threatened Species

There are a range of human activities and disturbances that threaten the diversity of species in the estuary (Figures 13 & 14). Management activities such as mowing of saltmarsh (now an endangered community) and seagrass wrack collection can have impacts on important ecological processes. Degradation of habitats can affect nursery habitats and important links between the catchment and the estuary. There are a number of environmentally significant areas in the estuary that are home to unique communities that need protection.

The Estuary Management Study set a number of objectives for managing biodiversity and threatened species to aid estuarine management (Roberts & Dickinson, 2005).

- The biodiversity and ecological function of the catchment shall be maintained in a manner that protects the estuary
- Minimise human disturbances that affect ecological function
- Maintain and protect environmentally significant areas and threatened species/communities
- Ensure fishery is sustainable

The following issues were identified by the focus groups as being the most important out of a list of all biodiversity and threatened species management issues (Roberts & Dickinson, 2005).

- Loss, fragmentation or degradation of habitat
- No ecologically sustainable target for catchment development
- Protective measures applied to development are difficult to monitor and enforce
- Assigning responsibility for managing environmentally significant areas
- Changes to flow volumes and patterns
- Human disturbance and built structures can threaten estuarine habitats
- Some local processes are threatening sensitive ecological communities and species but are not legally defined

Figure 13. Pipefish and seahorses are protected species within the lakes.

Figure 14. Poisoned saltmarsh, a threatened ecological community in the estuary.

2.5 Land-use

The change in landuse patterns in the catchment of Tuggerah Lakes in the last 150 years has significantly impacted the estuary. These changes have also provided opportunities for human settlement and in doing so has been an important mechanism in the economic growth of the Central Coast. The current landuse profile is shown in Table 3.

Table 3. Landuse distributions as a percentage of all land in the Tuggerah Lakes catchment

Landuse Type	**%**
Forestry and National Parks	37
Bushland	28
Extensive agriculture	14
Residential	10
Intensive agriculture	4
Wetlands	2
Industry/commerce	2
Turf farms/golf courses	1
Rural residential	1
Mining	<1
Disturbed land	<1
Ash dams	<1

In planning for additional urban settlement the allocation of undeveloped land in the catchment is important to the estuary as a large-scale decline in catchment ecology or further degradation of water quality flowing from the catchment is likely to impact on estuarine health. The Estuary Management Study set a number of objectives for managing landuse to aid estuarine management (Roberts & Dickinson, 2005).

- Ensure management of the estuary and catchment protects and enhances indigenous & non-indigenous **cultural heritage**
- Provide economically and socially justified levels of **development** whilst containing ecological impacts
- Support **forestry, agriculture and other industries** in the catchment while viability of downstream ecology is maintained

- Protect and restore **soil landscapes** and improve understanding of **land capability** and suitability in the catchment

Technical, Community and Business focus groups identified and prioritised the issues that make it difficult to meet these objectives. The five most important issues from the Estuary Management Study are summarised below.

- It is difficult to monitor the activities of land managers in the catchment to determine if they are implementing good management practices and to determine if those practices are working.
- Current programmes cannot identify and prioritise the range of erosion sites throughout the catchment including streambanks, eroding soils and development sites.
- There is not enough information on the land capability within the catchment. That is, developable land that is appropriately sloped land having soil types that are less likely to erode.
- Economic/market forces tend to drive landuse changes and development. Environmental impacts after often something that is “engineered in” after the landuse changes have been made. There needs to be a sustainable balance of both.
- In instances where land (including streambanks etc) has been reported as eroded or at risk of erosion, there is often insufficient funding or resources available to undertake remediation. This means that only a limited number of sites can be managed each year.

The management of landuse in the catchment will continue to be important for managing estuarine health, particularly given the development pressure that will be experienced in coming years. This management plan recognises the strong links between the catchment and estuarine health. It will recommend measures for managing the soil landscapes and land capability in areas such as streambanks, new development sites (including roads and residential areas) and existing industries (such as forestry and agriculture).

2.6 Socio-economic

The Tuggerah Lakes estuary is an important community asset and as such, the economic and social value of the estuary should be maximised. In economic terms this means supporting business and industry when it can be done without damaging the estuary. The community should be encouraged to use the estuary (foreshores and waterways), building a greater social value for the estuary and sense of community ownership.

2.6.1 Economic value

There is not a great deal of quantitative information on tourism and associated businesses around Tuggerah Lakes, however it is thought that boating and recreational fishing are important for tourism

around Picnic Point and The Entrance. The open entrance is also thought to be a visual attraction for tourists visiting The Entrance town centre. There are a number of sailing hire businesses around the lake, notably at Toukley, Canton Beach, North Entrance and Long Jetty which would presumably be aimed at the tourist market.

Tuggerah Lakes is the 5th largest commercial fishery in NSW and the 9th largest recreational fishery. The Munmorah Power Station (MPS) currently operates two generating units of the original four that were commissioned supplying 400GWh per year (about 2% of company supply and 0.6% of the State grid). The power station is a major local employer with some 200 people employed at a cost of $3 million/year.

2.6.2 Social value

The estuarine and riverine foreshores are some of the more popular recreational areas in Wyong Shire (Figures 15 & 16). Council has constructed a number of popular recreational areas along these foreshores. A bike path approximately 10 km long extends from The Entrance to Chittaway Point and is very popular for both walkers and bike riders. There are approximately 70 km of foreshores around the estuary used for a range of activities.

Of the 52 km of foreshore in developed areas, approximately 20% is in private ownership. Some residents have at times requested that Council assist in managing parts of their foreshore property for aesthetic amenity. This usually relates to the removal of seagrass wrack on the foreshore and in the lake. Council has historically taken the view that this is private property and that they should only be managing public foreshores (Roberts and Dickinson, 2005).

The estuary has a number of lake beaches including Long Jetty and Canton Beach. Residents and holiday-makers from the 1930's through to the 1960's have memories of "clean sandy beaches" around the eastern shores of Tuggerah, Budgewoi and Lake Munmorah (Scott, 2002). These shallow sandy shoals have experienced siltation as a result of increased runoff and sedimentation from their catchment. Canton Beach is the most popular lakes beach and is used for swimming, sailing, paddle boating, parasailing and prawning. Generally, swimming is not a popular recreational activity in the estuary when compared to boating or fishing. There are no statistics available on the usage of lake beaches over time, however anecdotal evidence suggests that there was increased use in some locations (Long Jetty and Canton Beach) after the completion of the Restoration Project (Roberts and Dickinson, 2005).

In terms of boating, Tuggerah Lakes tends to be more popular with small sailing craft than power boating. Budgewoi is used for both sailing and power boating (presumably due to its more protected waters), while Munmorah tends to be used mainly for power boating.

2.6.3 Issues and objectives

The Estuary Management Study (Roberts and Dickinson, 2005) set objectives for improving social and economic opportunities while protecting the long-term health of the estuary. These objectives were further enhanced by the Estuary Management Committee during the development of the Study.

- **Support existing industry** where it is ecologically compatible
- Ensure any **new commercial venture** is socially and economically justified and is ecologically compatible with the estuary
- Provide for **public access and amenity** at designated beaches and in designated recreation areas

During the development of the study, the focus groups identified a number of priority issues that would make it difficult to meet these objectives. In priority order they were:

- Currently, there are not sufficient settlement, employment and conservation strategies that could be used to justify or reject certain scales of development or industry.
- When development or industry is approved, there is often insufficient environmental impact modelling or pre-development ecological assessments so that the scale of impact (positive or negative) is poorly understood.
- Certain industries/businesses may be incompatible with the estuary, however this is not well understood
- Environmental degradation is difficult and costly to reverse once it has occurred, so there should be a premium on ensuring degradation is avoided.
- Some amenity issues experienced by the community around the foreshore (e.g. sedimentation, black mud) may be a result of previous land management practices and therefore requires remediation works rather than a change to existing land practices.
- While improving recreational areas is welcome, these areas are poorly defined and may overlap with important areas for rehabilitation.
- The community may not be using some foreshore areas because of inadequate facilities.

Figure 15. Fishing is a popular recreational activity around the lakes.

Figure 16. The Entrance provides significant tourism potential for the estuary.

2.7 Knowledge gaps

While significant improvements in the understanding of the estuary were made with the preparation of the estuary process study (Roberts, 2001), it was recognised that many gaps in existing data and knowledge about estuarine processes still remained (Figures 17 & 18). In addition, perceptions exist in the community about the so-called “health” of the estuary that do not necessarily reflect the most recent information or management actions.

The Estuary Management Study set a number of objectives for managing knowledge gaps to aid estuarine management (Roberts & Dickinson, 2005).

- Identify extent of information gaps and where appropriate undertake studies to improve understanding
- Ensure community is pro-actively involved in estuarine health and management

The following issues were identified by the focus groups as being the most important out of a list of all knowledge gap management issues (Roberts & Dickinson, 2005).

- Community scepticism about available estuarine knowledge, management intentions and management approach
- Funding and resourcing further studies into estuarine processes, health trends and key management questions
- Understanding of key estuarine processes is not complete
- Existing community perceptions about estuarine health
- General public are not actively informed through the most effective media channels

Figure 17. Understanding the processes that lead to wrack accumulation.

Figure 18. Investigating impacts to fisheries and threatened species.

2.8 Review of current best practice

The way in which plans are developed for the management of the coastal zone has undergone a major transformation in the last two decades. Traditional top-down “command and control” has given way to inclusive approaches in which managerial decisions are made through involvement of multiple stakeholders. It is widely accepted that good planning needs to incorporate stakeholder values, good science and economic valuation (Gregory & Wellman, 2001). The earliest illustration of this was the introduction in 1987 of the National Estuary Programme (NEP) in the USA. This programme facilitates cooperation between diverse stakeholders in particular estuaries but with a catchment focus. There are now 28 estuaries in the programme and research has shown that conflict resolution is significantly more successful in estuaries participating in the NEP than in others (Lubell, 2004).

In the early 1990’s the principle of “inclusivity” was promoted in Europe through a programme funded by the European Commission to demonstrate the advantages of integrated coastal zone management (ICZM). This approach not only facilitates the integration of the activities of diverse management authorities, but provides a framework for broad participation by business, conservation groups and the wider community. The programme resulted in the introduction of ICZM across the European Union in 2002 (UK Department of Environment, Food and Rural Affairs, 2006). There are now numerous estuary management initiatives in the United Kingdom, for example, that embody ICZM principles with local “ownership” and community participation in management, e.g. Humber Estuary Shoreline Management Plan (Winn et al., 2003) and Western Yar Estuary Management Plan (Isle of Wight Council, 2004).

Another feature of recent environmental management plans is the recognition of the need for adaptive management that is resilient in the face of changing physical and socio-economic conditions (Berkes & Seixas, 2005; Folke et al., 2005). In practice, this requires periodic review and re-formulation of objectives and strategies.

In Australia, estuary management plans now invariably involve broad consultation and embody stakeholder values and adaptive management. Good examples include the Gippsland Coastal Action Plan (Gippsland Coastal Board, 2002), the Integrated South-East Coastal Management Strategy (Tasmanian Department of Primary Industries, Water and Environment, 2002), and the Wellstead Estuary Management Plan (WA Department of Environment, 2005).

In NSW, waterway planning studies of major estuaries in the nineteen seventies and early eighties were focussed on publicly identified problems like bank erosion, lack of foreshore recreation facilities and particularly on boating needs including launching sites, shoaling and ocean entrances. While generally successful from an engineering viewpoint, they did not address that critical balance sought in present day EMP's between anthropogenic and ecological needs. Technical input was limited to coastal engineering and did not include ecological, economic and social considerations that are required in modern plans. Limited as those plans were, they did provide some understanding of the

physical processes in estuaries. In fact, the need for better understanding of natural estuarine systems was identified in light of the data that was assembled as part of these studies.

One important exception to the rule in this era was in fact Tuggerah Lakes, which was recognised as a special case as a result of its semi-eutrophic state. Tuggerah was the subject of an investigation directed by an interdepartmental committee established by the NSW Government. That committee commissioned more complex studies than those associated with other waterway planning exercises that included significant scientific as well as engineering input and thereby produced a product somewhat more akin to the EMP's that followed.

Since the NSW Government published the Estuary Management Manual in 1992, the 30 councils located in the coastal zone have established more than eighty estuary management committees to prepare EMP's. So far 50 plans have been produced for NSW estuaries ranging from small metropolitan lagoons to major systems like the Clarence River Estuary that encompasses several council areas. Implementation of the plans is well underway and another 30 or more are, like Tuggerah Lakes, approaching completion.

While most of the EMP's still largely comprise recommended schedules of physical works as their dominant output, they no longer ignore ecological and catchment concerns. Examples of management plans in NSW embodying the principles of inclusivity and environmental concern include the Lake Macquarie EMP (Lake Macquarie City Council, 1997), Port Stephens and Myall Lakes EMP (Port Stephens Council, 2000), Narrabeen EMP (Warringah Council, 2002), Berowra Creek EMP (Hornsby Shire Council, 2002), Wonboyne Lake and Estuary Management Plan (Bega Valley Shire Council, 2004) and the Tweed Coast Estuaries Management Plan (Tweed Shire Council, 2004).

Many of the modern EMP's relate to relatively small lakes or lagoons that lack the diversity of concerns and disparate interest groups faced in preparation of the Tuggerah Lakes plan. Those that are probably the most comparable to Tuggerah are Lake Macquarie and Lake Illawarra. The latter received special attention and funding in the nineteen eighties, as did Tuggerah and Lake Macquarie more recently with special NSW Government financial assistance. Of these, the Lake Macquarie EMP provides the best guide for the Tuggerah Lakes system, firstly, because the management structure is not embedded in a government agency, as it is for Illawarra for example and, secondly, in Lake Macquarie the delineation of preferred actions is far more mature than the situation faced at Tuggerah because a dedicated "Office of the Lake Macquarie and Catchment Co-ordinator" has been established.

2.8.1 Model Estuary Management Plans, Systems and Frameworks

From the above, several attributes that constitute best practice in the development of estuary management plans can be identified. A good plan will achieve the following objectives:

- Address all of the relevant issues currently impacting on the waterway.
- Address all of the relevant issues likely to impact on the estuary into the foreseeable future.

- Will have all objectives based on sound scientific principles.
- Will have been formulated through a comprehensive stakeholder consolatory process.
- Should be clearly documented and set out so that its ongoing implementation is easily understood.
- Responsibility for the implementation of the plan at both a global level and for individual actions should be clearly defined.

Two of the more comprehensive existing estuary management plans are those formulated for Lake Macquarie (Lake Macquarie City Council, 1997) and Berowra Creek (Hornsby Shire Council, 2002). These plans had significant resources injected into both the process studies and the plan production phases.

Important aspects of both plans include;

- The establishment of a vision and objectives for the management of the estuary.
- Significant emphasis on the importance of using good science to establish the need for any particular action.
- The use of the estuary management plan production process, as detailed by the DNR Estuary Programme Group, to produce the plan.
- The incorporation of the EMP into Councils' overall planning processes.
- Detailed stakeholder consultation.
- Description of the existing physical and ecological systems.
- Thorough detailing of the issues facing the estuary.
- Assessment of the potential management options available to address the documented issues.
- The establishment of a monitoring and evaluation framework for the process.
- A well set out actions document which clearly outlines issue, objective, action, source of action, who is responsible, approximate cost, prioritisation and monitoring frame work/indicators.

2.8.2 How this Estuary Management Plan meets best practice

The Tuggerah Lakes EMP is based on four main pillars: i) a clear statement of the vision and objectives of the plan; ii) an understanding of the issues facing the estuary; iii) good scientific information and iv) comprehensive consultation with stakeholders (Figure 19). The plan addresses the relevant management issues through a suite of Action Plans comprising Priority Programmes, each with a comprehensive list of Actions. The actions are the result of a thorough analysis of options

incorporating expert and community input. Close liaison with Wyong Shire Council (WSC) and stakeholder groups ensures that the plan “belongs” to the community. Adherence to the DNR estuary management plan production process also ensures the support of relevant government agencies. No plan is complete without a mechanism for periodic review and assessment and this plan makes appropriate recommendations as to how this can best be achieved. Council should be confident that this plan embodies all the elements characteristic of plans considered to be among the best in the world.

Figure 19. Providing comprehensive stakeholder consultation and community education.

3 Planning Considerations

3.1 Stakeholders

3.1.1 Wyong Shire Council

Wyong Shire Council is the largest land manager in the Tuggerah Lakes catchment. In 2003/4 WSC spent nearly $200m on key management responsibilities and a similar expenditure is forecast for the current financial year. Of this, about $4m is expected to be spent on estuarine and catchment management. While management of inland waterways is the responsibility of the State, WSC has for many years undertaken remedial and maintenance works to enhance the estuarine environment. In recent years the emphasis has been on understanding the functioning of the estuary and catchment as an integrated ecosystem. The completion of the estuary process study was a significant step in the move towards holistic management (Roberts, 2001).

3.1.2 Gosford-Wyong Councils Water Authority

The GWCWA is responsible for supplying safe drinking water to the New South Wales central coast. Their responsibilities include construction and maintenance of dams and water infrastructure such as treatments plants. As a regulator of water flow, they have an important role in catchment management, particularly in relation to environmental flows in Wyong and Ourimbah creeks that are important to the wellbeing of the Tuggerah Lakes estuary.

3.1.3 Catchment Management Authorities

The Catchment Management Authorities Act 2003 established 13 new catchment management authorities (CMA's) in New South Wales to replace the catchment management boards. The Hunter-Central Rivers Catchment Management Authority (H-CRCMA) is responsible for managing the catchment of the Tuggerah Lakes among others. The H-CRCMA receives most of its funds from the Commonwealth Government's Natural Heritage trust with matching contributions (financial and in-kind) from the State Government. Over the period from 2004 to 2007 it is expected that funds totalling $18.7m will be made available to the H-CRCMA from these and other local sources. The H-CRCMA has developed a Catchment Action Plan (CAP) that provides the framework within which the H-CRCMA will collaborate with local government to achieve agreed management targets over the next ten years (H-CRCMA Draft CAP, January 2006). The Tuggerah Lakes EMP has been developed with the CAP in mind in order to gain maximum benefit from this collaboration.

3.1.4 NSW Government

NSW Department of Environment and Conservation (Parks and Wildlife Division)

DEC (P&W) manages two reserves within the Tuggerah Lakes catchment, Wyrrabalong National Park and Munmorah State Conservation Area. Each has a plan of management that caters for prevention of soil erosion, sedimentation and excess runoff and for bush regeneration and weed control (Coyners, 2004). The recent listing of saltmarsh as a threatened ecological community will increase DEC (P&W) involvement in foreshore management around Tuggerah Lakes.

NSW Department of Environment and Conservation (Environmental Protection Authority)

The Department of Environment and Conservation (DEC) has been involved with the Tuggerah Lakes estuary through funding stormwater projects such as the Stormwater Management Plan (Dickinson, 1999) and research components of the Estuary Process Study (Roberts, 2001). WSC submits annual State of the Environment reports to DEC. The involvement of DEC in continuing support for ongoing data acquisition and investigations of improved managerial options is vital for the future protection of the estuary.

NSW Maritime Authority

NSW Maritime Authority is responsible for management of navigable waters and provision of maritime infrastructure throughout New South Wales. The Authority collaborates with WSC on issues such as dredging of The Entrance channel and provides funds to the Council for development and improvement of boating infrastructure. Continued cooperation between the Authority and WSC is important for the successful implementation of the EMP.

Department of Natural Resources

The Department of Natural Resources (DNR) role in managing catchments and estuaries is mediated largely through local government authorities and the recently established Catchment Management Authorities. The Tuggerah Lakes catchment falls within the boundaries of the Hunter-Central Rivers Catchment Management Authority (see section 3.7.2).

NSW Department of Primary Industries (Fisheries)

DPI (Fisheries) is the lead agency in the conservation and management of fisheries resources. The agency administers licensing for commercial and recreational fishing in the Tuggerah Lakes. DPI (Fisheries) has an important role to play in the protection and management of seagrass habitats in the estuary and close collaboration with the Estuary and Coastal Management Committee will be important in this regard.

NSW Department of Primary Industries (Forestry)

DPI (Forestry) operates in three forestry areas in Wyong Shire; Olney, Ourimbah and Wyong State forests. With over 17% of the Tuggerah Lakes catchment under the control of DPI (Forestry) their role in catchment management is significant. Although consultation between WSC and DPI (Forestry) occurs on an ad hoc basis, the EMS noted the potential for a more formal arrangement in which DPI (Forestry) could be included.

NSW Department of Lands

The Department of Lands owns most of the foreshore and bed of the Tuggerah Lakes estuary. As such, it administers a wide variety of managerial activities relating inter alia to dredging, waterfront occupancy, sport, tourism and industrial and agricultural activities.

NSW Department of Aboriginal Affairs (Aboriginal Land Council)

The Aboriginal Land Council was established by the Aboriginal Land Rights Act (1983). The Council is empowered to undertake a number of activities pursuant to the objective of protecting the rights and furthering the aspirations of the Aboriginal community. Collaboration with the ALC, in particular the Darkinjung Local ALC, will be important in ensuring appropriate and sensitive management of areas of cultural importance to native Australians.

3.1.5 Federal Government (Department of Environment and Heritage)

DEH is responsible for environmental management and policy in Australia. The role of this agency in catchment management, although indirect, is particularly important since most the funding for the Catchment Management Authorities comes from the DEH through its Natural Heritage Trust.

3.1.6 Contributors to Estuary Management Planning

A range of non-government organisations participated in discussions and/or made comments relating to the Estuary Management Study and were also involved in the development of the Estuary Management Plan. It is important that these organisations continue to be directly involved in the finalisation of the Estuary Management Plan and the establishment of the Action Plans as appropriate.

3.2 Policies and Legislation

3.2.1 Estuary Management Policy

Estuary Management Plans are a major tool by which the objectives of the Coastal Policy are met. The NSW Government developed the Estuary Management Policy in 1992. Specific objectives of the Policy were:

- the protection of estuarine habitats and ecosystems in the long-term, including maintenance in each estuary of the necessary hydraulic regime;
- the preparation and implementation of a balanced long-term management plan for the sustainable use of each estuary and its catchment, in which all values and uses are considered, and which defines management strategies for:
    - conservation of aquatic and other wildlife habitats
    - conservation of the aesthetic values of estuaries and wetlands
    - prevention of further estuary degradation

- repair of damage to the estuarine environment
- sustainable use of estuarine resources, including commercial uses and recreational uses as appropriate.

3.2.2 Coastal Policy

The NSW Coastal Policy (1997) is the state government's policy for the management of the NSW coastal zone. This includes the NSW Estuary Management Policy under which estuary management plans are developed. The Coastal Policy is based on the principles of ecologically sustainable development contained in the Intergovernmental Agreement on the Environment signed in 1992 as follows:

- conservation of biological diversity and ecological integrity
- inter-generational equity
- improved valuation, pricing and incentive mechanisms
- the precautionary principle.

The Coastal Policy lists the following pivotal goals:

- to protect, rehabilitate and improve the natural environment
- to recognise and accommodate natural processes and climate change
- to protect and enhance the aesthetic qualities of the coastal zone
- to protect and conserve cultural heritage
- to promote ecologically sustainable development and use of resources
- to provide for ecologically sustainable human settlement
- to provide for appropriate public access and use
- to provide information to enable effective management
- to provide for integrated planning and management.

3.2.3 Water Reforms

In 1997 the NSW Government announced a series of water reforms aimed at achieving clean, healthy rivers and groundwater systems and the productive use of water by:

- better sharing of available water
- enhancing investment strategies for the rural water sector
- Reshaping how water management is delivered.

Estuary and Floodplain Management Committees play a key role in the delivery of these water reforms. Catchment Management Authorities have now also been established by the NSW Government to integrate natural resource management at a catchment level.

Central to the 1997 water reform package is the setting of water quality objectives and river flow objectives. Estuary Management Committees are encouraged to develop these objectives through the plan production process.

The water quality objectives for estuaries include the protection of:

- aquatic ecosystems
- visual amenity
- secondary contact recreation
- primary contact recreation
- aquatic foods (cooked) and commercial shellfish production.

Where possible it is recommended that local data be collected on which to base the development of estuarine management targets and indicators.

The river flow objectives for estuaries are to:

- maintain wetland and floodplain inundation
- manage groundwater for ecosystems
- minimise effects of weirs and other structures
- maintain or rehabilitate estuarine processes and habitats.

Specific measures have been proposed to achieve these objectives which include the maintenance of wetland and floodplain inundation, the management of groundwater for ecosystems, the minimisation of the effects of weirs and other structures and the maintenance or rehabilitation of estuarine processes and habitats.

All of these objectives and measures are relevant to the management of estuaries and should be incorporated into the goals, objectives, strategies and actions of the Estuary Management Plan.

3.2.4 Summary of Government Policies

Federal and State Governments administer a number of policies that have some relevance for the Tuggerah Lakes estuary and its catchment. A summary of the more relevant ones is provided in Table 4.

Table 4. Related Commonwealth, State and Local Government Policy

Jurisdiction	Formal Name	Description
Commonwealth	National Water Reform Framework - Council of Australian Governments, 1994	This framework relates to the management, use, protection and, where necessary, restoration of health of water resources and water dependent ecosystems.
	Wetlands Policy of the Commonwealth of Australia, 1997	The purpose of this policy is to integrate wetland management within the broader context of environmental management, with the goal of repairing and managing wetlands wisely.
	National Strategy for Ecologically Sustainable Development, 1992	This Strategy sets out principles and objectives for achieving ecologically sustainable development in Australia.
	National Strategy for the Conservation of Australia's Biodiversity, 1996	The strategy sets out principles that underpin objectives and actions that are required to protect Australia's biodiversity.
	National Principles for the Provision of Water for Ecosystems, 1996	This policy aims to sustain and, where necessary, restore ecological processes and biodiversity of water-dependant ecosystems by ensuring the provision of water for ecosystems.
	National Water Quality Management Strategy, 1992	The objective of this strategy is to achieve sustainable use of the nation's surface and groundwater resources by protecting and enhancing their quality while maintaining economic and social development.
	National Dryland Salinity Programme, 1993	Programme to prevent dryland salinity.
	National Principles and Guidelines for Rangelands Management, 1999	Provides for sustainable management of Australia's rangelands.
	National Action Plan for Salinity and Water Quality, 2000	Addresses the issue of salinity and water quality in priority areas.
	Natural Heritage Trust (extension 2002-2007)	The Trust aims to stimulate regional activities to conserve, repair and use sustainably Australia's natural resources. Rivers, coasts and wetlands are a major focus.
	National Land and Water Resources Audit, 1997	Comprehensive nationwide appraisal of Australia's land, water and vegetation resources.
New South Wales	NSW Coastal Policy, 1997	Environmentally sustainable development of the coast through water quality management, regulation, protection, restoration, State Environmental Planning Policy No. 14 - Coastal Wetlands (SEPP14), State Environmental Planning Policy No. 26, conservation, reserve systems, Acid Sulphate Soil management, planning, cultural heritage protection, monitoring research & management.

Jurisdiction	Formal Name	Description
	NSW Estuary Management Policy, 1992	A component policy of the NSW State Rivers and Estuaries Policy 1993 for the protection and management of estuaries.
	NSW Fisheries Policy and Guidelines - Aquatic Habitat Management and Fish Conservation, 1999	Provides background material and description of fish habitats and resources, relevant policies and legislation. Identifies activities that impact on aquatic habitats, compliance activities, guidelines for mitigating impacts, conservation activities and appropriate environmental assessment.
	NSW Groundwater Dependent Ecosystems Policy - draft	Protection of groundwater dependent ecosystems, including groundwater dependent wetlands. Applies five management principles covering values, extraction, quality, precautionary principle and appropriate use and development.
	NSW Weirs Policy, 1997	Aimed at halting and where possible reducing and remediating the environmental impact of weirs. Eight management principles outline construction, removal, modification, regulation, maintenance, riparian protection, rehabilitation and respect for the impact of weirs.
	NSW State Rivers and Estuaries Policy, 1993	Developed for the improved management of rivers and estuaries and their floodplains. The policy sets out six principles for sustainable management.
	NSW Wetlands Management Policy, 1996	Sets out the objectives and nine management principles for the management of wetlands. Overseen by the NSW State Wetland Action Group (SWAG), a whole-of-government committee.
	State Environmental Planning Policy No. 14 (SEPP14) - Coastal Wetlands, 1985	Protects mapped wetlands in the coastal zone of NSW (outside the Sydney metropolitan region). Requires development consent for the clearing, draining or filling of wetlands, or levee construction.
	State Environmental Planning Policy No. 19 (SEPP19) - Bushland in Urban Areas, 1986	Protection of natural bushland in local government areas listed in the schedule, which are reserved for public open space purposes. Development consent must be obtained before bushland is disturbed.
	State Environmental Planning Policy No. 44 (SEPP44) - Koala Habitat, 1995	Protection of Koala habitat, including Swamp Mahogany, commonly associated with wetlands. The policy applies to the local government areas within the known geographic range of Koalas. Councils may not issue development consent without investigating core Koala habitat.

3.2.5 Legislation

Related Legislation administered by the Department of Natural Resources includes:

- Catchment Management Authorities Act 2003 No 104
- Coastal Protection Act 1979 No 13
- Dams Safety Act 1978 No 96
- Farm Water Supplies Act 1946 No 22

- Forestry and National Park Estate Act 1998 No
- Hunter Water Act 1991 No 53, Part 5, Division 8
- Irrigation Areas (Reduction of Rents) Act 1974 No 83
- Native Vegetation Act 2003 No 103
- Native Vegetation Conservation Act 1997 No 133
- Natural Resources Commission Act 2003 No 102, Part 3
- Rivers and Foreshores Improvement Act 1948 No 20
- Soil Conservation Act 1938 No 10
- Water Act 1912 No 44
- Water Management Act 2000 No 92

3.3 Funding Bodies and Opportunities

There are a range of possible funding sources to assist in the implementation of Estuary Management Plans.

3.3.1 State Funding (Agencies)

The Department of Natural Resources and NSW Maritime Authority administer a number of programmes at a State Level, which are relevant to estuaries and generally available on a 50:50 basis.

- The DNR Estuary Management Programme provides technical advice, data collection and funding assistance for estuary management plan development. Actions flowing from the plans may also be funded on a 50:50 basis.
- The DNR Waterways Infrastructure Development Programme provides technical advice and funding assistance for works to improve the recreational amenity of the waterways such as boat launching ramps, public wharves and jetties, dredging, and foreshore amenities. These can be up to 100% of project costs.
- The DNR Coastal Management Programme provides technical advice, data collection and funding for the design and construction of works that conserve or improve beaches and public reserves and for coastal studies and coastline management plans.
- The DNR Floodplain Management Programme provides technical advice, data collection and funding assistance. Projects can include studies and works that reduce the impact of flooding and flood liability.
- The Waterways Asset Development and Maintenance Programme (WADAMP, NSW Waterways) provides funding for works to improve the amenity and management of waterways. Funding is usually 50% of the total project costs. Projects such as wharves, jetties and seawalls can be funded under this programme.

3.3.2 State Funding (H-CRCMA)

The Hunter-Central Rivers Catchment Management Authority (H-CRCMA) has produced a draft Catchment Action Plan (CAP) to guide investment in catchment management over the next ten years. Management targets in the CAP include the following;

- Enhance and protect wetlands
- Manage nutrient runoff
- Protect native riparian vegetation
- Instream and foreshore stabilisation
- Environmental management systems
- Floodgate management
- Treat animal pests
- Erosion and sediment control, roads
- Stabilise actively eroding soils
- Protect marine habitat
- Enhance marine shorelines
- Urban stormwater management
- Enhance foreshore vegetation
- Regenerate native riparian vegetation
- Rehabilitate acid sulphate soils
- Effluent management
- Treat weeds
- Restore fish passage
- Revegetate highly erodible soils
- Sustainable grazing management
- Threatened species work
- Restore instream habitat

The Tuggerah Lakes Estuary Management Study (Roberts & Dickinson, 2005) was based on the former Central Coast Catchment Blueprint, which was subsequently rolled into the new H-CRCMA and its CAP. As a result of this framework, these management targets overlap considerably with the actions listed in this plan. The H-CRCMA should be seen as the significant partner when sourcing funds for the implementation of the Estuary Management Plan.

3.3.3 Federal Funding

The Commonwealth Government Natural Heritage Trust (NHT) provides funding to projects which address the causes of environmental and natural resource degradation. Relevant NHT programs include:

- The Bushcare Programme
- The National Rivercare Programme
- The National Wetlands Programme
- The Marine Species Protection Programme
- The Coastal and Marine Planning Programme
- Work for the Dole
- The Coastal Monitoring and Vulnerability Assessment Programme
- The National Landcare Programme
- The Endangered Species Programme
- The Fisheries Action Programme
- Coastcare
- The Capacity Building Programme
- Green Corps

3.4 Management Framework

3.4.1 Adaptive Management & ISO14001

Adaptive Management

Adaptive management is the incorporation of the scientific method (experiments) into a management framework (policy decisions) (Aldridge et al., 2004). Adaptive management is a challenging blend of scientific research, monitoring and practical management that allows for experimentation and provides the opportunity to "learn by doing" (USEPA, 2000). Underwood (1999) made the observation that rather than competing with one another, the adaptive management logic and the scientific hypothesis logic mirror one another at key stages of their respective processes. Adaptive management is different from reactive management in that the latter is often unreplicated and lacks statistically valid experimental design, often producing unreliable information (Hurlbert, 1984; Wilhere, 2002). It is also different from passive adaptive management which involves long-term monitoring and learning from a gradually evolving management strategy (Walters, 1986). This process often becomes reactive trial-and-error management when funds committed to monitoring are removed. If processes other than management are causing the variability (i.e. environmental variability like weather patterns), it can make causal relationships difficult to discern (Aldridge et al., 2004; Bormann et al., 1999).

Adaptive management is not without its problems:

- The main reason for failure is that the process rarely progresses from the model development stage to the design and implementation of field experiments. Walters (1997) suggests that experiments are often opposed by people protecting self-interests in management bureaucracies and proponents of adaptive management need to be forceful and expose these groups and their interests to public scrutiny.
- Adaptive management requires effective implementation of experiments, which may be expensive or risk-prone compared with baseline options (Walters, 1997). Public agencies by nature are risk averse and manage for the status quo (Halbert, 1993).
- The information feedback loop is broken, meaning learning is inhibited and there is no evolution of management policies. This loop typically is broken because managers are looking (by necessity) for short-term responses and feedback from management policies (Moir & Block, 2001).

Adaptive co-management

Traditionally, adaptive management rests with ecosystem managers in a government framework. It does not couple local knowledge to ecosystem management and environmental feedback. Adaptive co-management combines the "dynamic learning" characteristic of adaptive management with the "linkage" characteristic of co-operative management and with collaborative management (Olsson et al., 2004). It is a relatively new concept that extends the adaptive management process to include

localised implementations and user groups. This is particularly important for the Tuggerah Lakes system where user groups (e.g. commercial fishermen) have significant local knowledge and experience that would be useful in formulating, trialling and evaluating management approaches.

Aside from making the adaptive management process more robust, adaptive co-management increases the level of ownership felt by the respective user groups. In some cases, this sense of ownership has seen local users develop ecosystem management practices and evaluation techniques that transcend administrative boundaries. There are 7 principles that support the development of co-management systems for ecosystems:

- Enabling legislation that creates social space for ecosystem management
- Funds for responding to environmental change and for remedial action
- Ability for monitoring and responding to environmental feedbacks
- Information flow and social networks for ecosystem management
- Combining various sources of information for ecosystem management
- Sense-making for ecosystem management
- Arenas of collaborative learning for ecosystem management

The Tuggerah Lakes Estuary Management Plan is well placed to incorporate adaptive co-management as elements of the above principles are embedded within it.

ISO 14001

The environmental performance of an organisation is of increasing importance to internal and external stakeholders. Achieving sound environmental performance requires organisational commitment to a systematic approach and to continual improvement of the environmental management system (EMS). ISO 14001 is an international standard for the development and implementation of an EMS. It is supported by IS0 14004 and has five key principles:

1. **Commitment and policy**

   An organisation should define its environmental policy and ensure commitment to its EMS.

2. **Planning**

   An organisation should formulate a plan to fulfil its environmental policy.

3. **Implementation**

   For effective implementation, an organisation should develop the capabilities and support mechanisms necessary to achieve its environmental policy, objectives and targets.

4. **Measurement and evaluation**

   An organisation should measure, monitor and evaluate its environmental performance.

5. **Review and improvement**

An organisation should review and continually improve its environmental management system, with the objective of improving its overall environmental performance.

3.4.2 Gap analysis

In reviewing both Adaptive Management and IS0 14001 principles, it is possible to identify areas where an estuary management plan for Tuggerah Lakes could be improved.

1. Development of an estuary management policy

   Wyong Shire Council has taken an active role in the management of the estuary for many years. This Estuary Management Plan is a commitment to continue to look after the estuary and its catchment. However, the organisation does not have an overarching policy that sets boundaries for what it will and won't do in terms of estuary management. This makes it difficult to set limits on expenditure and activities and consequently makes long-term plans such as this estuary management plan less certain. This is the reason it is set as the first of the ISO 14001 principles. An estuary policy would make Council's commitment to estuary management transparent and accountable. This will be increasingly important should additional public money be put towards the management of the lakes.

2. Commitment to adaptive management and co-management

   Traditionally, estuary management plans stop at the planning and implementation phase (Principles 2 and 3) and fail to recognise the importance of continuing to measure, evaluate, review and improve (Principles 4 and 5). Council has spent significant time and money in researching some key estuarine processes, but has not traditionally evaluated or modified its approach on the basis of the information it receives. Additionally, estuarine management has not done a good job of respecting and engaging with knowledgeable local user/interest groups. It is recommended that the implementation of the plan be firmly placed within a framework that makes adaptive management and co-management explicit.

3.4.3 Linking to key Council documents

Council's core business is conducted through the use of a number of management documents and landuse planning instruments (Table 5). The Estuary Management Plan should link to these documents in order to embed estuary management as part of Council's core business.

Table 5. Outline of key Council documents

Management Documents	
Council Management Plan	This is the primary document that describes Council's plan for operations in the Shire in a financial year. Substantial commitments to estuary management should be announced here as well as performance in previous years.
Council Policies	Policies should be updated or where necessary, created to reflect Council's position on important estuary and catchment management issues. This makes the position explicit and more likely to be reflected in how the whole of Council operates.
Department Business Plans	These plans describe the responsibilities and budgets for Council departments. It is recommended that the estuary/catchment management commitments of Council departments be expressed here. Annual projects related to the estuary should be budgeted here.
Cultural Plan	Council has a Cultural Plan that aims to create a "cultural focus" for the Shire. Given that the estuary forms a key part of the identity of the region, links should be made with the Cultural Plan to create a positive image and encourage people back to the lakes.
Stormwater Management Plan	The SMP sets Council's stormwater management agenda. Historically it has been a strategic document aimed at improving stormwater management across the organisation. Council is probably in a position now, to direct the SMP in a more action oriented way. This would be an excellent vehicle for delivering the stormwater management improvements outlined in this EMP.
Operational Plans	Operational Plans include things like maintenance regimes and could include Seagrass harvesting plans. These plans could be harnessed by an estuary manager to direct Council efforts in ways that help the estuary overall.
Procedure Manuals	These documents instruct outdoor staff in the methods they should use when undertaking tasks like maintaining stormwater traps, reserves, and operating dredges and seagrass harvesters. They present an opportunity for the Estuary Manager to improve the operations of Council staff, which are often undertaken in public view. Poor practices can undermine confidence in Council's commitment to estuary management.
Landuse Plans	
Wyong Local Environment Plan (LEP)	This is the primary landuse planning document in Council. It designates what constitutes appropriate use of land including setting land aside for conservation, development and recreation. There is potential for the foreshore areas to be targeted under the LEP and designated as either recreation or conservation areas. This will give some certainty to future management of

Management Documents	
	the foreshores.
Development Control Plans (DCP)	DCP's are plans that control development activity in the Shire. Engineering Guidelines for development and Water Sensitive Urban Design are both examples of guidelines that have been turned into DCP's. Where robust management of development is required to protect the estuary, the estuary manager should work with planners to create DCP's that aid the long-term management of the estuary.
Plans of Management	Individual plans of management can be very useful for describing Council's vision for managing public land. This is a model that could be used to manage significant wetlands, catchment habitats, recreation on the estuary, and general foreshore management. Where a community ownership model is proposed for managing a particular site, often the plan of management is the first requirement.

Consideration should be given to linking to key documents of external stakeholders to ensure that estuarine management responsibilities are carried through to their core business as well.

4 Developing the Plan

The estuary management plan has been written in close consultation with Wyong Shire Council as the principal catchment and estuarine manager. There have been two significant influences on the development of the plan. One of the first tasks in developing the plan was to provide detailed costs for the recommendations from the Estuary Management Study (Roberts & Dickinson, 2005). The second main influence was engaging with the range of stakeholders to better understand their needs and hopes for managing the estuary in the future. The importance of these influences is discussed below.

4.1 Budget estimates and estuary funding

Council has long recognised that improving estuarine management will require significant increases in funding. While some funding is expected from the State and Federal governments, it is clear that ratepayers will need to make additional contributions in the form of a rate rise or levy. Council wants to begin implementing the estuary management plan in the 06/07 financial year and as such a levy or rate rise would need to be in place by then. The Council Management Plan is developed in March each year and publicly exhibited for 8 weeks prior to adoption by the end of the financial year in June. Council required detailed estimates of likely estuarine management programmes in order to document the levy/rate rise in the Council Management Plan. To meet this commitment, a budget estimates report (Dickinson et al., 2006) was prepared and submitted to Council in February 2006. The estimates are based on the recommended priority programmes that were identified in the Estuary Management Study (Roberts & Dickinson, 2005).

These programmes were expanded to include the detailed actions in this Estuary Management Plan. The actions and associated costs were refined in a workshop with key estuarine managers held earlier in 2006. The report (Dickinson et al., 2006) documents anticipated estuarine management expenditure over a 5-year period. Existing expenditure was estimated at $2.4 million p.a. for programmes related to estuarine management. Projected expenditure was expected to increase by an estimated $6.9 million p.a. to a total of $9.3 million p.a.

Council has two main ways of raising revenue from ratepayers; a special levy or a general rate rise. A special levy is generally a temporary levy on top of ordinary rates and may have a sunset clause. It is usually reserved for special on-ground works or activities. It is common practice to set spending criteria and establish a Committee to oversee the allocation and expenditure of levy funds. This can make it difficult to apply the funding to areas that may not fit within the defined categories (such as additional staffing to cope with the extra workload associated with spending large sums of money). Another difficulty associated with levies is that they are often structured in a way that limits spending on maintenance (however the proposed stormwater levy allows for maintenance), which is counter-intuitive considering that the levy often generates large amounts of on-ground works with a long lifespan and maintenance demands.

By comparison, a general rate rise tends to be adopted without the same set of constraints or oversight. This makes it easier to vary how and where the funding is spent. It can also include increased staff and maintenance levels which helps support implemented on-ground works. Without the appropriate oversight however, it is conceivable that funding could be distributed to other Council operations unrelated to estuarine management (eg. roads, sporting fields etc). This could make the community more sceptical of a general rate rise.

Given the perceived importance of stormwater management to the overall health of the estuary, Council decided to implement a stormwater-based levy that can be used to target elements of estuarine management that are related to stormwater. This levy is expected to generate approximately $1.5 million annually.

4.2 Consulting with stakeholders

The consultation programme that has been implemented for this management plan is described in detail in Muston (2006). The main elements of this report are summarised below.

Exchange of information between stakeholders and plan makers is fundamental to the NSW Government's estuary management planning process. Interaction between Wyong Council and others who have interests and responsibilities in estuarine management has been ongoing since 1997. Its form depends on the stage in the planning process:

- Council - the elected local representatives oversee, review and adopt the plan (ongoing role);
- Tuggerah Lakes Estuary Management Committee – involves stakeholders with specific interests in estuarine managerial outcomes in planning, monitoring and reviewing the Management Plan (ongoing role);
- Reference Groups – specific interest clusters who meet for focussed discussion (formed during the Estuary Management Study stage and retained for the Estuary Management Plan stage);
- Inclusion of objectives and principles that are the product of negotiation or consultation for other programmes;
- Members of the general community – alerted by public notices and/or public exhibitions of the stage of the planning and opportunities to make submissions.

4.2.1 Objectives

The consultation programme aims to invite information from a range of interest groups. The consultation objectives underpinning the programme were set as:

- broad stakeholder understanding of the final stage of the plan making process;

- broad stakeholder understanding of the consequences of implementing the Estuary Management Plan;
- dissemination of balanced, objective information to assist stakeholders in understanding the problems, alternatives and opportunities associated with managing the Tuggerah Lakes estuary;
- opportunities for interested stakeholders to exchange information and opinion relevant to estuarine management;
- stakeholder feedback received by the project team and addressed where relevant during the plan making process;
- current environmental, economic and social issues identified and addressed in the Estuary Management Plan;
- the draft Estuary Management Plan accessible to stakeholders for review and response.

4.2.2 Consulting Tools

The communication tools were designed to be widely accessible and to act as alerts that final written submission is invited. In this last stage of the plan-making, one-on-one discussions are confined to workshops with the three Reference Groups (Business, Community and Technical), Estuary Management Committee and Council meetings.

General community – Print media – Alerting tool

Print media was chosen as the main vehicle for developing community-wide awareness that the estuarine management planning process is drawing to a close. A print media schedule of weekly advertorial and media releases that were focused on the 5 key management themes raised community awareness. The print media carried advertisements about how to access displays and exhibition documents to alert people who wanted to make final submissions prior to Council's adoption of the estuary management plan. The response to the media advertorial and advertisements was monitored to ensure that responses were collected and fed into the planning process.

General community – Council website – Alert and feedback tool

Council's website was used as the repository of all documents related to the planning process and another vehicle for raising community awareness that the estuarine management planning process was drawing to a close. The texts for the media advertorials, displays and exhibition of documents were made available. A link was also added to the website to provide email access for submission of opinion direct to Council. Responses were collected.

General community – Static display – feedback tool

Static displays were the third communication tool used for raising general community awareness that the estuarine management planning process was drawing to a close. Static displays were positioned

in three shopping centres (Tuggerah Westfield, Lake Haven and Bay Village) and Council Chambers (a total of 4 display locations). The displays contained a central panel that would remain on display for information related to the planning timeline and advising how to submit feedback. Two additional panels were produced that carried coloured photographs and text that amplified the managerial outcomes with information summarised on the central panel. The displays were staffed on an open day enable an exchange of information and collection of suggestions and issues.

Future estuary managers: local schools

The estuary plan and its contents were considered too complex to act as an ongoing common focus for community participation in future management of the estuary. Historically, many of the messages exchanged within the community about the status of the estuary are negative and do not encourage optimism and participation. This is a common situation that has been overcome in other locations by community-wide adoption of a symbol or 'human scale' icon; something that can be easily remembered and easily associate with managerial successes. To this end, local primary schools have been engaged in a colouring competition that will contribute to the development of an icon relevant to the Tuggerah Lakes, the seahorse. The finalist's work was incorporated into the final management plan.

Structured discussions – focus planning workshops

Four structured planning workshops were undertaken to discuss the options/actions/consequences that should be included in the Management Plan. The reference groups established during development of the estuary management study were used and augmented where appropriate (representation in these groups is shown in Appendix B) and included:

- Technical working group comprising Council staff and State agency representatives
- Business working group comprising members of the Chambers of Commerce and significant employers in Wyong Shire
- Community working group comprising representatives from indigenous, environmental and recreational groups.
- Tuggerah Lakes Estuary, Floodplain and Coastline Management Committee

The structure of the workshops encouraged identification of ecological, social and economic outcomes sought from future management of the estuary.

4.2.3 Outcomes from pre-plan consultation

Community Feedback – Shopping Centre Open Days

There were a number of issues raised by the visitors to the displays at Bay Village, Lakehaven, and Westfield Tuggerah Shopping Centres. These are summarised in Table 6 below:

Table 6. Feedback from the Community – Shopping Centre Visits

Issue	Comment
Wrack/foreshore management:	• suggestions for removing it from the foreshore (Rocky Point and Prawn beach featured prominently in discussions)
	• people have a desire to use the foreshore to access lakes, but feel they can't because of conditions
Commercial Fishing	• suggestions from some lakes users that commercial fishing is removing too many fish from the Lakes
	• local fishers seem concerned that commercial fishing gear rips out seagrass which then floats to the shore and may exacerbate the ooze problem. They also suggested that this might increases seagrass loss
Entrance Management	• some residents have suggested that Council needs to keep the Entrance open permanently and place any dredged sand from the channel on the south side instead of north side of The Entrance
Levy	• people seemed generally happy with the work proposed under the levy. Others suggested they would be happy to pay more given the proposed work programme.
Streambank Rehabilitation	• some people suggested that a significant increase in this rehab was needed especially in the estuarine sections of the rivers and creeks

Community Feedback – Reference Group

A community reference group workshop was held on the 5th April 2006 (its membership is shown in Appendix B). The issues in Table 7 were raised and suggestions made to strengthen the effectiveness of the EMP.

Table 7. Feedback from the Community – Reference Groups

Issue	Comment
Public accessibility to and comprehension of the EMP.	• The estuary management outcomes were generally supported by the participants. • The part of the draft EMP reviewed by the reference group was considered by them to be communicated at a scale and complexity that made it difficult for them to relate to the contents of the plan and the form of the overall management initiative. • In response, a recommendation that emerged from

Issue	Comment
	within the group was that the local community would find it easier to relate to the EMP if it could be communicated to them at a local level; described by some as a "sub-catchment", "precinct", "village", "where we live" level. • The discussion also suggested that Council work groups should operate on a precinct basis so they develop a greater sense of responsibility for their actions at particular locations and a greater understanding of that part of the lake, its history and the management outcomes sought for it.
Integration with other plans that influence the condition of Tuggerah Lakes or processes that impact upon it.	• Suggestions that the EMP needed to operate in an integrated way with other plans that control Council operations
Effective adaptive management promoted by flexibility in the EMP.	• The plan should be flexible enough that new information would trigger modification of the management activities, and new technologies could be embraced that would enhance estuary management outcomes. • Review of the EMP was suggested to be often enough to take advantage of new information, a 2-5 year review cycle was mentioned. • Comment was made that the 5-year plan recommended by the draft EMP for stormwater remediation upgrades was too short a time period.
Consistent performance of all whose activities influence the condition of the estuary and its foreshore areas.	• Participants considered that Council staff or its contractors, developers and land care groups had undertaken activities that compromised the condition of the estuary. • In some cases the activities were considered to have eroded the benefits already gained from volunteer and Council's own rehabilitation efforts in some areas. • There was a strong call for ongoing training of all people whose activities occur on, or impact on, the foreshore areas of the lakes.
Council capacity to implement the EMP.	• Doubts were expressed by some participants about Council's capacity to implement the EMP successfully. • This discussion was extended by some to suggest that an 'independent' body should be formed to hold responsibility and accountability for the outcomes it achieved through allocation of estuary management funding and implementation of programs.
Priority setting.	• The apparent complexity of the draft EMP generated many questions about priority setting. It appeared that participants needed to understand the criteria that would be used to identify priority actions before they could feel comfortable endorsing parts of the draft EMP. • A suggestion was made that priority setting should include a geographic basis and it seemed this would offer the reassurance that they sought.

Issue	Comment
Involvement by residents and land carers.	• Concern was expressed that State Government agencies needed to understand and become involved in the estuary management outcomes sought in the draft EMP. • Concern was expressed that if this did not occur, the benefits of the EMP could be reduced if State Government agencies over ruled Council's land management and development approval decisions. • This concern was expressed particularly in relation to management strategies to protect of ecologically sensitive areas (from the impacts of new coalmines) and population strategies developed to protect the estuary.
Involvement by schools.	• Awareness and involvement by primary and secondary school children was seen as a key to the future sustainability of the estuary. • It was suggested that: o The information contained in the estuary management planning documentation be transferred into curricula and project materials for local schools. It was suggested that the theme be "where you walk, visit, meet your friends or live" to recognise that not all of the school student live beside the lakes. o The curricular support materials be made locality specific to engage more readily with the students and teachers. o Incentives are developed for schools to present their project activities and findings to land 'care' groups and in this way develop strategic relationships between the two groups. o Incentives are developed to encourage student groups to report findings of their projects and activities to other student groups and in this way develop strategic relationships between the groups from different areas and schools. o Mandatory programs of study in the estuary be introduced to in primary and secondary schools.
Involvement by businesses.	• There are incentives for businesses and sporting clubs (such as bowling clubs and other sporting clubs that managed playing fields) to develop and implement land & water management plans to ensure that their activities have minimum impact on the estuary. • There are incentives for companies and clubs to become involved, such as an "adopt a foreshore area'" program where their activities and achievements are clearly visible, promoted by the Council and rewarded.
Involvement by fisheries stakeholders.	• Concern was expressed about impacts that trawler fishing and fisheries bi-catch may have on the habitat value of the lakes. • It was suggested that some of the fishing licence money be transferred to management of the estuary.
Involvement by indigenous	• A suggestion was made that involvement by, and

Issue	Comment
stakeholders.	strategic partnering with, indigenous groups would encourage a beneficial transfer of indigenous land care ethics of responsibility for the condition of the land.
Activity specific.	• That the Council review the design of its gross pollutant traps because it was considered that some don't work and/or represent unattractive features on the lake foreshore. • That the foreshore designated recreation area activities recommended in the EMP address the Long Jetty foreshores a matter of priority. • That a full time waterways officer be appointed for Tuggerah Lakes support Priority Program # 1 in the draft EMP (stream bank rehabilitation). • Introduction of flow measurement capabilities into all new stormwater outlets on the lake foreshores and retrofit to existing ones, in order to support the Council's stormwater control capacity. • Increased funding and increase in the range of dredging activities on the basis that the present benefits from dredging was considered to be limited. • Also on this topic, it was suggested that a study be done of the return movement of dredged sand into the lake in storm events. A suggestion was also made to place the dredged sand on the beaches. • Guidance about where to place sediment dredged at river mouths was suggested to be included in the EMP. • Increase in the level of community involvement in WaterWatch water quality testing to increase awareness about stormwater control devices and the quality of the water entering the lakes via such devices. • Measurement of flows entering the lakes so that a record of flows can be obtained to support identification of appropriate environmental flows. • Inquires were made about: • Whether the EMP would result in funding for stream bank fencing by private landowners (such as occurs in the water catchment areas). • Whether artificial wetlands were being recommended.
Involvement by State Government.	• Concern was expressed that State Government agencies needed to understand and become involved in the estuary management outcomes sought in the draft EMP. • Concern was expressed that if this did not occur, the benefits of the EMP could be reduced if State Government agencies over ruled Council's land management and development approval decisions. • This concern was expressed particularly in relation to management strategies to protect of ecologically sensitive areas (from the impacts of new coalmines) and population strategies developed to protect the estuary.

Business Feedback – Reference Group

A business reference group workshop was held on the 6th April 2006. The following issues were raised and suggestions made to strengthen the effectiveness of the draft EMP (Table 8). The membership of the Business Reference Group is shown in Appendix B.

Table 8. Feedback from Business Reference Group

Issue	Comment
Clarity within the plan	• A clear statement of the end point sought by the EMP concerning lake waters, sections of the shoreline and catchment, i.e. the answer to "What does a healthy estuary look like?"; "Why we should invest in this"
	• A statement of agreed tactics that will be applied to estuarine management: "What? By whom? When? At what cost?"
	• "What force does the EMP have to influence/constrain the activities of the business community?"
	• A "critical path" analysis for achieving improvements in estuarine condition.
Critical success factors	• Good governance (clear responsibility and accountability)
	• A simple message that motivates all people to be conscious of and involved with estuarine management
	• A greater level of understanding and statement about the value of the lake system to the community
	• Commercial certainty – long lead times from investment to actually getting returns. Need to know that they can invest the money for the long-term.
	• Clear priorities in desired outcomes
	• Education: This was seen as a high priority to correct misconceptions and unrealistic expectations for lake management outcomes.
	• Mechanisms that provide visible recognition of actions that a business community member takes in relation to enhance estuarine condition.
Integration with other plans	• There are a large array of existing planning instruments that business works with. Concern was expressed that the EMP might become another hoop to jump through.
	• Concern was also expressed that the EMP would fail to achieve its desired outcomes unless it was integrated with the existing set of planning instruments.
Shift in public perceptions	• There was general concern that business felt unfairly targeted by members of the public as the primary sector that causes decline in the condition of the estuary; particularly mentioned was a perception that business activities "pollute the lakes".

Issue	Comment
	• Business stakeholders are more likely to become involved in estuary if EMP implementation has the capacity to shift the image to one where the business sector is more commonly recognised for the contribution that it makes to estuarine sustainability
Business incentives and priorities	• Infrastructure on lake foreshores that enhances the visual attractiveness of the estuary for visitors and residents
	• Mechanisms of public recognition of businesses that make investments (e.g. Adopt a foreshore)
	• The point was made that the ”banks” set many priorities for businesses and that these could influence the initiatives that are available for businesses to become involved in contributions to estuarine management activities.
Involvement where benefits may be eroded by activities of other stakeholders	• The business reference group expressed concern that unless the EMP integrated the activities of all stakeholders, the actions of others could take gains sought by business investments of effort, time or money.
Strategies	• “Adopt a Foreshore”
	• A lake credits scheme.
	• A business task force to oversee the business side of the estuary management actions.
	• Business partnerships with land care groups, social clubs etc.

Technical Stakeholder Feedback – Reference Group

A technical reference group workshop was held on the 5th April 2006. The Technical Reference Group offered extensive commentary on the specifics of each set of actions. These comments were incorporated directly into the tables in each Action Plan as it was impractical to include the whole set in the EMP.

4.2.4 Exhibition of the draft EMP

The draft Estuary Management Plan was placed on exhibition for 4 weeks (June/July 2006) during which time comment was sought from the community and State Agencies. Field days were also held at a number of locations around the estuary to give interested parties an opportunity to discuss elements of the plan and their own local experiences. The intention was that this would help elicit robust and constructive feedback during the exhibition process.

Comments were received from residents, community groups, businesses, State Agencies and other stakeholders. The comments were summarised into a report to Council. The comments were then considered in terms of the information already in the plan and appropriate changes made to include this important feedback into the final Plan.

4.3 Developing Action Plans

4.3.1 Overview

Extensive community and stakeholder consultation as part of the Estuary Management Study established a schedule of 27 priority programmes to address the most important of the issues facing the estuary. Those programmes were reviewed by council and agency experts and a detailed suite of actions were developed for inclusion in this EMP. Following discussions with the reference groups (Technical, Community and Business), it was decided that the priority programme titles should be modified to better reflect what the programme was trying to achieve. These modifications are shown in Appendix A.

All the measures arising from the Estuary Management Study were considered to be of sufficient merit to warrant their inclusion in the Estuary Management Plan. However, they need to be arranged in a manner appropriate to delivery of estuary improvement outcomes specific to the Tuggerah Lakes system. With this in mind they were grouped into the four action plan areas detailed below for the preparation of the plan.

Action Plans	Priority Programmes	#
Water quality	Stormwater management-new urban areas	2
	Stormwater management-existing areas	3
	Maintenance of stormwater devices	20
	Audit for compliance in catchments	8
	Educate people about stormwater pollution	26
	Develop a sub-catchment prioritisation tool	9
	Recreational water quality	10
	Streambank rehabilitation	1
	Sustainable use of water	27
Ecological	Foreshore rehabilitation	5
	Maintenance of foreshore rehabilitation areas	22
	Protect important catchment habitat	17
	Restore degraded catchment habitat	4
	Monitor key wetlands	11
	Limit access to sensitive parts of the estuary	7
	Assess riverine ecology and river flow	24
Socio-Economic	Foreshore recreation facilities	6
	Maintain foreshore recreation facilities	21
	Develop partnerships with business	14

Action Plans	Priority Programmes	#
	Develop a population strategy	12
	River mouth dredging	19
	Entrance management	18
Knowledge & Management	Develop an estuary management body	15
	Prepare and implement a funding strategy	16
	Address key estuary management questions	23
	Develop partnerships with universities	13
	Educate community and stakeholders about the estuary	25

Current levels of expenditure on the estuary are distributed primarily to water quality (40%) and anthropological activities (50%), with little expenditure on ecology or knowledge and management activities. This imbalance needs to be addressed in the management plan by applying "new" resources to achieve the recommended balance.

In a properly balanced Estuary Management Plan, it is considered that resources directed at implementation should ideally be shared equally between water quality actions (25%); ecological actions (25%); anthropogenic actions (25%); and knowledge/management actions (25%).

Given that water quality, ecology, and knowledge & management are prerequisites to any form of effective improvement in estuary wellbeing, the target distribution of resources as proposed under the plan is considered to represent an equitable balance between ecological and anthropogenic needs, particularly as it directly reflects the findings of the Estuary Management Study without any amendment or adjustment of measures identified by both experts and by the community as part of that study. In this regard each of the priority programmes arising from the Estuary Management Study are included in the schedules detailing work to be undertaken as part of the following four action plans.

4.3.2 Reading the Action Plans

Budget & Costing

The Budget columns are comprised of three components, a startup cost, an implementation cost and an ongoing cost. The startup cost relates to the cost of getting a programme started including approvals, liaising with relevant stakeholders, writing tender documents etc. The implementation cost is the one-off cost of undertaking an action (including first pass expenses not covered in ongoing costs). The ongoing costs reflect commitments to ongoing programmes of maintenance or continual improvement over the 5-year life of the plan. The one-off costs were amortised over the 5-years and combined with ongoing costs to establish a likely annual budget.

Priorities

Assigning priorities is a difficult task, because there are a number of levels at which they could be applied, and a number of factors that could be used to apply a priority. For example, some actions are a priority because they prevent other projects from being started. Some others may have a priority because the issues or problem requires urgent attention. Other items might be important simply because they establish an efficient spending framework. Given the diversity of actions being recommended, a single priority system is not recommended.

All of the goals in an Action Plan are considered important, however indicative priorities for each priority programme are discussed in the goal section of an Action Plan to help when budgetary restrictions are likely to prevent implementation. The actions are listed in their preferred implementation order. In some cases, individual actions that would ideally happen later, have a higher priority indicating that immediate action is more important than planning out a measured set of site specific actions.

This Estuary Management Plan provides both a priority (1 – 3) and a reason behind the priority to help judge which actions to implement. This is particularly important where a choice needs to be made between two equally prioritised actions. Table 9 provides a summary of the priorities used in the Estuary Management Plan.

Table 9. Description of the prioritisation framework

Ranking	
1	Most important – should be implemented during the 1st yr Action Plan.
2	Should be implemented as soon as possible, but could be reduced or deferred for no more than a year if budget is limited.
3	Important, however it can tolerate being deferred until subsequent years if required.
Description	
Efficient Planning	The action is an important step in allocating resources effectively. It enhances the delivery of the overall project.
Keystone	The action is actually preventing the sensible implementation of other actions/programmes.
Urgent	Damage is occurring or will occur unless this action is implemented immediately.
Checking	These actions are review mechanisms that help complete the feedback loop in adaptive management.
Implementation	These actions do not have urgency other than being the implementation component of a priority programme.
Locations known	This means that while the implementation suggests a certain order in which things should be done, work can start without plans because locations are already known.

Priority Programmes

The priority programmes from the Estuary Management Study have been grouped together under common goals in the Action Plans. There are numberings located on the tables in the Action Plans (and are designated by “PP”). These numbers indicate what priority programme they are sourced from in the Estuary Management Study. Following discussions with the reference groups (Technical, Community and Business), it was decided that the priority programme titles should be modified to better reflect what the programme is trying to achieve. These translations are shown in Appendix A.

5 Water Quality Action Plan

5.1 Outline

5.1.1 Why is water quality important?

The Tuggerah Lakes system and Lake Illawarra are the only major NSW coastal lakes where water quality has historically degenerated to eutrophic levels. In both cases, whilst catchment and entrance works have been undertaken to relieve the problem in the medium term, the threat of future eutrophication remains. This threat will increase with time, particularly if new measures cannot be found to contain rising nutrient and sediment supplies from rapid and continued urbanisation of the catchment. Poor water quality can affect all life that uses the estuary, from recreational swimmers to seagrass habitat and fish. With this in mind, maintaining good water quality in the Tuggerah Lakes system is the most important issue to be addressed by the Estuary Management Plan.

5.1.2 Who should be involved and what should they be trying to achieve?

The Action Plans are annual documents that will help meet the Estuary Management Plan goals for Water Quality, Ecology, Social and Economic Opportunities, and Strategy for the next 5 years. Every financial year, each Action Plan should be reviewed to see if targets have been met, and this review should influence planning the actions for the following year. The Action Plan will need to be implemented by a number of stakeholders, who could form a “Water Quality Action Team” and should be involved in guiding the actions, priorities and budgets each year. It is expected that the estuary management entity/manager will be ultimately responsible for delivering the action plan. The Water Quality Action Team should be relatively small, focussed and involve the following stakeholders (Table 10).

Table 10. Stakeholders for the Water Quality Action Plan

Stakeholder	Why are they important for Water Quality actions?
NSW Department of Natural Resources	Responsible for State Estuary Management - Review proposed actions and provide funding opportunities (consult with other agencies as required depending on relevance. Lands may be particularly relevant for Streambanks)
Hunter-Central Rivers Catchment Management Authority	Provide advice on linking to the Hunter-Central Rivers CAP programmes to access grant funding. This is particularly important for streambank works which the H-CRCMA is already involved in.
Council Staff	Representatives from Natural Resources, Engineering and Health Services should be involved to provide expert review guidance on the actions that they are expected to implement. (This should include representation from the Water Authority as needed).
Committee/Advisory Board	Important for review of the proposed actions and how they relate to Estuary Management Plan goals and objectives.

Stakeholder	Why are they important for Water Quality actions?
Local residents	Any actions that involve on-ground works near to, or affecting local residents, must involve robust consultation with the residents. This allows for local knowledge to be incorporated into the design process and gives residents an opportunity to comment on the proposal.

Action plans are the primary tool for getting estuary management happening "on the ground". They describe how to meet estuarine objectives and address priority estuarine issues within budget and time constraints. It is important to identify the overarching objectives that the action plan needs to satisfy, so that subsequent revisions remain consistent (Table 11).

Table 11. Relevant Estuary Management Study Components

Principle (Catchment Blueprint)	Water quality and quantity meet community needs and natural ecosystem requirements
Objectives (EMS)	• Provide adequate environmental flow to sustain estuarine and riverine ecology • Maintain water quality to protect healthy ecosystem function in the estuary and rivers • Provide water quality in rivers and the estuary safe for primary human contact • Maintain flow patterns while minimising flooding threat to life and property • Provide adequate water for community water supply • Minimise changes to groundwater flow/stores
Priority Issues - Why can't the objectives be met? (EMS)	• Increased sediment and nutrient loads from existing landuses affect water quality (WE2) • Increasing population puts an increased demand on water supply (WS1) • Increased sediment and nutrient loads from new development affect water quality (WE3) • Foreshore and streambank erosion adds sediment to waterways (WE7) • Toxic contaminants in runoff could affect aquatic ecology and human health (WE4) • Water supply and irrigation needs get priority over river flow for environmental needs (WF1) • Changes in water quality can affect aquatic and semi-aquatic vegetation (VE2, VR2) • Inadequate understanding of riverine ecological processes and riverine water quality to allow for environmental flow management (VR5) • Changes to flow volumes and patterns (DF2) • Difficult to monitor activities of landholders (LA2) • Insufficient programmes in place to investigate and rehabilitate erosion sites (LS2)

5.1.3 How will these actions help?

The Estuary Management Study identified 27 programmes to address priority issues. Of these, 9 related to improving water quality and flow reflecting its importance to the estuary. The proposed programmes (called Priority Programmes and designated with a prefix of “PP”) have been grouped according to estuarine management goals for water quality and quantity over the next 5 years:

- Improving stormwater quality from the catchment
- Improving recreational water quality
- Stabilise foreshore and streambank erosion
- Encourage sustainable use of water

Essentially, this will result in better swimming conditions in the estuary, better water quality for animals and plants, less blockage of river mouths and smothering of habitat, and appropriate river flow to the estuary.

5.2 Goals for 2006-2011

Council has primary responsibility for the implementation of these works although there are secondary roles for the Department of Environment and Conservation (EPA and NPWS), Community Groups, NSW Maritime Authority, Gosford-Wyong Water Authority, Department of Natural Resources and the Hunter-Central Rivers CMA.

5.2.1 Improve quality of stormwater from the catchment

To tackle this problem a range of stormwater measures were proposed in the Estuary Management Study. The first stormwater measure involves imposing new stormwater design and construction controls on new development to confine all future export of sediments and nutrients to levels as close as possible to pre-existing background levels (Figures 20 & 21). In practice, it may prove practical to treat stormwater discharged from several new and existing developments at a common site further down the catchment and this should be encouraged subject to an appropriate sharing of the costs with new development beneficiaries. This should be the financial responsibility of developers as a condition of development approval, but Council will incur costs in ensuring compliance and in regard to subsequent maintenance of storm water devices.

Additional stormwater management devices and/or retarding works should also be implemented to treat pollution streams from existing development. This is a responsibility of Council where circa $0.4 million per annum is already expended. However, the plan proposes an even higher level of expenditure on this single measure reflecting its significance in addressing the water quality issue. Unlike maintenance, it involves new initiatives, which may attract grants from the other two tiers of government over time. It is also an area where new development further up individual sub-catchments may be called upon to help fund downstream retrofitting projects where they can be designed to also

treat stormwater runoff from such new developments as well as from existing homes and businesses. This has been an ongoing activity in the catchment since the Tuggerah Lakes Restoration Programme in 1988.

There should be an increased focus on effective maintenance of stormwater treatment devices, including gross pollutant traps and artificial wetlands, because such devices cease to perform a useful function if they are not maintained on a regular basis. Council already expends significant funds in the order of $0.24 million per annum on maintenance of stormwater devices and this cost is likely to increase in the future as the population expands and as more devices are retrofitted to existing areas. The plan proposes to increase the maintenance budget to both address the existing maintenance requirement and to cater for a significant increase in provision of new stormwater devices under the plan.

The most efficient way of controlling stormwater pollution is by reducing the amount of pollutants before they enter the stormwater system (treatment in the system is expensive). There are two main strategies for reducing pollution at the source. The first involves conducting audits of landholders and businesses to check for good pollution control practices, and then helping them improve any deficiencies. This is an arena where Council already has a small financial liability of about $20,000 per annum. Much more is needed to better control/police effluent management, which has a potentially significant impact on water quality. However, given the relatively small scale of industry in the Shire, and the existing responsibilities of DEC in respect of point source pollution (the management of onsite sewage treatment systems is Councils sole responsibility), this is seen as a second order priority to be pursued if an environmental levy is forthcoming in the future. It is important to recognise that the focus is on working together to limit pollution, rather than implementing punitive measures. The second source control strategy is an education programme targeting the broader community including residents, tourists and businesses. Like most other elements in this action plan it is a second or third order priority matter but nonetheless a very important one in the long term. This will likely be the sole responsibility of Council with the imminent decommissioning of the EPA's Stormwater Trust.

Funding stormwater pollution control is expensive and so resources should be allocated to areas where they are going to make the biggest difference in protecting and managing the lakes. It should be focused on the delivery of nutrients, pathogens and sediment to the lakes and should be regarded as a first-order priority. As it is related to stormwater outcomes such action could be funded from a stormwater levy. Council is already considering such a programme in the form of a catchment pollutant model (probably MUSIC). Provided the model is being constantly re-assessed and calibrated with real data, over time the predictions from the model will improve, allowing Council to direct resources to the sub-catchments that need it most.

In summary it is proposed that stormwater management command a significant proportion of the total funds, both existing and "new", made available by Council to support the ongoing health of the Tuggerah Lakes estuary.

Figure 20. Stormwater drain entering the lake.

Figure 21. Artificial wetland and gross pollution trap.

Maintain natural nutrient and sediment loads and water flows after new development (PP2)

Benefits of meeting the target
Sediment/nutrient loads to the creeks and lakes should remain in check while the catchment continues to be developed

Risks of doing nothing
Waterways downstream of the development may experience algal blooms, poor water quality and damage to habitats like seagrass.

EMS Issues Addressed
Main Issue: (VR2) Changes in water quality can affect aquatic & semi-aquatic vegetation
Other Issues: (WE3, WF1, WG1, VR1, VF1)

Fixing a symptom/cause or providing an enhancement?
Cause

Proposed actions:

Action	Comments	Cost			Responsibility	Implementation		Priority
		Start-up	Implement.	Ongoing		Location	Timeframe	
2.1 Review stormwater management plan to improve strategy for new urban areas including DCP's, guidelines and any supporting works.	Stormwater Mgt Plan needs revision especially for new development areas. It should reflect current best practice for urban stormwater management (liaise with HCCREMS to learn from their work).	$20,000	$50,000		**WSC**	Developing areas	Yrs 2 & 5	2 – Efficient planning
2.2 Develop and apply an assessment protocol to determine appropriate stormwater interventions (in terms of flow and water quality) for new development.	Very important to understand the base conditions in a catchment before development, in order to assess effectiveness of measures.		$100,000	$10,000	**WSC,** DEC	Warnervale, WEZ & other dev. areas	Yr 1	1 – Urgent
2.3 Design and cost stormwater harvesting and stormwater pollution control infrastructure (including ongoing maintenance costs).	Consider involving/liaising with universities and research centres to access most up-to-date information	$20,000	$20,000	$150,000	**WSC**	Warnervale, WEZ & other dev. areas	Ongoing	2 – Implementation
2.4 Manage the installation of infrastructure (funding will occur through s.94 contributions).	Continuation of existing programme. Use this process to enhance in-house knowledge.		$20,000	$100,000	**WSC**	Warnervale, WEZ & other dev. areas	Ongoing	2 – Implementation
2.5 Assess effectiveness of stormwater management programmes in achieving objectives and adjust management plans accordingly.	Use new information to revise the "New development" component of the SMP, and any appropriate development/design guidelines.	$10,000		$50,000	**WSC**	Warnervale, WEZ & other dev. areas	Yrs 2 - 5	2 – Efficient planning

Evaluation and Management

- This is a rapidly evolving field. Many new treatments are expensive and untested in Wyong. Accordingly, assessing successes and failures is critical for good governance.
- Consider linking up with universities and business (see programs 14 & 15) to examine ways of achieving multiple outcomes that meet economic and ecological objectives.

Reporting

- Inform community of successes/failures so they learn as Council learns
- Promote successes to peers through conferences/literature as many other Local Governments are facing similar challenges

Funding

- Stormwater levy, H-CRCMA programs, Water fund (especially if linked to water reuse)

Supporting Information

- The works have been costed at $16million for stormwater harvesting – this is collected through s94 contributions (as will ongoing water quality treatment devices). Any shortfall will be met by sale of water costs, grants, Council funds.
- Develop a life cycle asset management approach to water quality treatment assets. Include natural assets such as streams and the estuary in this approach.
- Ensure staff are appropriately trained (use the capacity building budget in priority programme 25).
- Link with the catchment audit modelling and field data (programme 9) to determine appropriate stormwater interventions for new areas (flow and water quality).

Reduce nutrient and sediment loads from existing development (PP3)

Benefits of meeting the target	Risks of doing nothing	EMS Issues Addressed	Fixing a symptom/cause or providing an enhancement?
Reduction in nutrient and sediment loads caused by development over the last 50 years.	Too much sediment and nutrients can cause algal blooms, poor water quality, and affect fish, sponges and seagrass.	Main Issue: (WE2) Increased sediments and nutrients from exiting development affects water quality Other issues: WF1, VR1, VF1, VR2)	Cause

Proposed actions:

Action	Comments	Cost			Responsibility	Implementation		Priority
		Start-up	Implement.	Ongoing		Location	Timeframe	
3.1 Prepare a 5yr plan for stormwater remediation upgrades focussing on priority catchments first rather than available space.	Give priority to catchments where creeks, streams, wetlands and the estuary would benefit from load reductions. Look to maximise ecological benefit.	$5,000	$20,000		**WSC**	Urban areas	Yr 1	2 – Efficient planning
3.2 Undertake design and construction on a 5yr plan as part of the drainage infrastructure upgrade programme.	Existing programme. This should be continued until it can be improved by the 5 yr plan. Ensure that existing mistakes are not repeated in future design.		$10,000	$600,000	**WSC**	Urban areas	Yr 1	1 – Urgent
3.3 Assess the performance of the devices and link back to design and management plans.	Review using rigorous experimental design		$100,000	$100,000	**WSC**	Urban areas	Ongoing	2 – Checking

Evaluation and Management

- This programme may shift in importance and scale following the “mixing study” (see programme 23), however improving health of urban and rural streams should always remain a priority.
- Tie to the maintenance of stormwater device programme (20). Look for reductions in the volume of material being removed from the traps in catchments with improved stormwater management.
- Outcomes from the evaluation (3.3) should be fed back into planning (3.1) and design (3.2) on an annual review basis.
- Consider ways of incorporating ecological stream health into the evaluation process (see work being done by CRC for Catchment Hydrology)
- Be careful to allocate funds to projects that are most likely to work. Retrofits are expensive and should not be spent on locations where minimal benefit is likely (the money may be better spent on other projects).

Reporting

- Stormwater Management Plan, SOE
- Successes/failures should be made transparent and reviewed by the estuary manager and any technical advisory board as it has the potential to absorb a large amount of funds

Funding

- H-CRCMA programmes, Stormwater levy

Supporting Information

- Council has flagged a $200,000 increase in the drainage infrastructure upgrade programme (brings it up to $600,000).
- Use the catchment audit process (PP9) to prioritise the upgrades.
- Develop a life cycle asset management approach to water quality treatment assets and include natural assets such as streams and the estuary in this approach.

Maintain stormwater traps and collect information on the material removed (PP20)

Benefits of meeting the target	Risks of doing nothing	EMS Issues Addressed	Fixing a symptom/cause or providing an enhancement?
Keep traps operational and informs management of changes in sediment and gross pollutant loads that would otherwise enter the estuary.	Traps export sediment and gross pollutants to the estuary. No opportunity to understand if loads are increasing/decreasing in response to catchment practices	Increased sediment and nutrient loads from existing development affects water quality (WE2)	Symptom

Proposed actions:

Action	Comments	Cost			Responsibility	Implementation		Priority
		Start-up	Implement.	Ongoing		Location	Timeframe	
20.1 Continue existing maintenance programme				$300,000	**WSC**	Existing STZ's, wetlands and GPT's	Yr 1	1 – Urgent
20.2 Review adequacy of existing devices and retrofit devices where necessary to improve performance and maintainability	Some of this work has been completed for GPT's and STZ's, but not more recent devices. Ensure maintenance crews are involved in the design of retrofit devices.			$150,000	**WSC**	Urban areas	Yr 1	1 - Implementation
20.3 Develop a system for handling, processing and disposing of collected material	Handling and disposal can be expensive and potentially hazardous.	$20,000	$30,000		**WSC**		Yr 2	2 – Efficient planning
20.4 Record data on collected material				$1,000	**WSC**		Yr 1	1 - Checking
20.5 Review data and feed into catchment management decisions and design of future devices	Use this data to learn about effectiveness of existing designs. Past mistakes should not be repeated.			$20,000	**WSC**		Yr 2 – 5	2 - Checking
20.6 Review adequacy of maintenance programmes.	Maintenance programmes may not be keeping devices working efficiently, or may be unnecessary damaging to surrounding environments.		$15,000		**WSC**		Yr 2	2 - Checking

Evaluation and Management

- This is an important review mechanism to assess the effectiveness of catchment works and education programmes
- Measure changes in loads removed through time and space to determine whether catchment interventions (structural or education) have worked.

Reporting

- Information should be included in the SOE and revisions of the Stormwater Management Plan

Funding

- Stormwater Levy

Supporting Information

- The increased budget is designed to ensure that GPT's are cleaned as frequently as necessary, and to allow for increased maintenance of the constructed wetlands (including removal of sediment and weeds). It may need to increase further to account for tipping fees.
- The $150,000 retrofit is intended to be a programme of improvements to existing devices to improve either the performance or the maintainability of the devices.
- The $20,000 start-up cost is to investigate OHS and disposal implications for collected material. The $30,000 implementation cost is for developing appropriate procedures for maintenance and disposal of collected material.
- The $20,000 ongoing cost for review is intended to provide a mechanism for the maintenance crews to advise on design of stormwater treatment systems, and also for incorporating collected data into management planning.
- Consider linking the output from this process to the catchment audit priority programme (PP9).

Help landholders and business to limit pollution at the source (PP8)

Benefits of meeting the target	Risks of doing nothing	EMS Issues Addressed	Fixing a symptom/cause or providing an enhancement?
Improved dialogue with landholders, business operators and the community – a co-operative approach to pollution reduction	Continued poor practices leading to stormwater pollution	Main Issue: (SC3) Protective measures applied to development are difficult to monitor and enforce Other Issues: LA2, LS2, LS3, WE2, WE3	Cause

Proposed actions:

Action	Comments	Cost			Responsibility	Implementation		Priority
		Start-up	Implement.	Ongoing		Location	Timeframe	
8.1 Develop a rationale and criteria for conducting audits	Focus on educating and assisting keeping punitive measures as a last resort.		$50,000		**WSC**	Catchment wide	Yr 1	1 – Efficient planning
8.2 Undertake the audits and provide constructive advice	There may be a need for a dedicated Catchment Liaison Officer/s. Provide assistance to landholders/business to improve practices rather than be punitive.	$10,000		$220,000	**WSC**	Catchment wide	Yrs 1 – 5	2 – Implementation
8.3 Link results from the audits to management planning				$5,000	**WSC**	Catchment wide	Yrs 2 - 5	3 – Checking

Evaluation and Management

- Audits must be designed to educate and improve activities on land including intensive agriculture, small businesses, developers etc.
- Review the number of people who were non-compliant and look for a reduction in this number over time, as the audit process spreads and general education improves.

Reporting

- SOE, Stormwater Management Plan

Funding

- Consider linking to a university research programme to determine best methods for obtaining compliance
- Some revenue may come from fines etc (need to be explicit about whether revenue should be raised this way)
- H-CRCMA programs

Supporting Information

- The Technical Focus Group felt that the co-operative approach was much more helpful in the long-term than punitive measures
- This programme should work with the broader pollution education campaign
- The audit rationale should be based on selected priority catchments and priority land uses/businesses to target for compliance.
- Consider using audits to minimise discharges from private connections.

Educate people in the catchment (including residents, tourists and industry) about reducing pollution (PP26)

Benefits of meeting the target
Reduce pollution at the source, reducing the need for expensive treatment devices and their maintenance. Healthier catchment habitats and urban streams.

Risks of doing nothing
Continued need to install treatment devices. Catchment and stream habitats continue to be degraded.

EMS Issues Addressed
Main Issue: (WH4) Toxic contaminants in runoff can affect aquatic ecology and human health
Other Issues: VW3,VE3,VR2,SP3,DC3,WE2

Fixing a symptom/cause or providing an enhancement?
Cause

Proposed actions:

Action	Comments	Cost			Responsibility	Implementation		Priority
		Start-up	Implement.	Ongoing		Location	Timeframe	
26.1 Identify key groups that need to be targeted	The main focus of this programme is to stop stormwater pollution at the source. Different groups may need different approaches and respond to different media.		$10,000		**WSC**		Yr 1	1 – Efficient planning
26.2 Devise and implement the education programme	Use a range of media and link with audit programmes in PP8.		$100,000	$100,000	**WSC**		Yr 1	1 – Implementation
26.3 Assess attitudinal and behavioural change through time to determine effectiveness				$30,000	**WSC**		Yrs 2 - 5	3 - Checking

Evaluation and Management

- This programme is a recognition of the importance of controlling pollution at the source – it is far less expensive in the short and long-term compared with structural measures to filter/remove pollutants.
- The programme should reduce pollution and habitat degradation and this should be measured through behavioural change.
- It is recommended that Council work closely with experienced behavioural change consultants to assist in implementing these programmes.

Reporting

- The success of the programme should be reported in the SOE
- Consideration should be given to publishing this information so that other organisations can learn from Wyong's experience.

Funding

- There are periodic opportunities for grant funds to change behaviour

Supporting Information

- The programme should reduce weed infestation and key pollutants at the source, especially nutrients, sediment, litter and the disposal of chemicals in stormwater drains.
- The programme should be tailored to target all land activities that degrade or threaten estuary health including but not limited to residents, sporting clubs, intensive agriculture etc.
- The $100,000 implementation cost covers the cost of letting a consultancy to devise a strategy for each of the key groups identified in 26.1.
- The $100,000 ongoing cost is expected to be spread across a range of user groups (e.g. landholders, sporting groups, industry, broader community, gardeners).

Develop an assessment tool that helps determine which sub-catchments need priority assistance (PP9)

Benefits of meeting the target	Risks of doing nothing	EMS Issues Addressed	Fixing a symptom/cause or providing an enhancement?
Efficient allocation of resources to mitigate stormwater pollution. Sub-catchments most in need will be managed first.	Scare resources spent in areas where the benefits may be small	Main Issue: (WE2) Increased sediment and nutrient loads from existing landuses affects water quality Other Issues: WE4, WH3	Enhancement

Proposed actions:

Action	Comments	Cost			Responsibility	Implementation		Priority
		Start-up	Implement.	Ongoing		Location	Timeframe	
9.1 Develop a process/system for assessing which catchments are a high priority, and what type of intervention is required	The system may be in the form of a catchment model or subjective ranking process. Council has indicated a preference for using the MUSIC model.		$100,000		**WSC**	Catchment wide	Yr 1	1- Efficient planning
9.2 Collect catchment data and device performance data to improve understanding of priorities and responses	This is critical in order to obtain meaningful model output, and is also important for qualitative desktop prioritisation.	$5,000	$100,000	$150,000	**WSC**	Catchment wide	Yrs 1 –3	1 – Efficient planning
9.3 Undertake the assessments on an annual basis for prioritising works	This should be part of an in-house programme.			$30,000	**WSC**	Catchment wide		2 – Efficient planning
9.4 Use the information for refining planning (Stmw Mgt Plan) and doing the drainage upgrades (programme 3)				$5,000	**WSC**	Catchment wide		2 - Checking

Evaluation and Management

- Link to data collected from treatment devices to improve performance estimates
- Focus tends to be on meeting hydrologic targets – consider incorporating ecological responses/targets as part of individual studies.
- Field data are very important in checking assumptions and priorities
- Staff involved in designing/implementing the works should be involved in the prioritisation process to make it transparent and share knowledge/refine approach

Reporting

- SOE
- Stormwater Management Plan

Funding

- Strong consideration should be given to involving universities and research centres to reduce costs and take advantage of best practice in a rapidly evolving field

Supporting Information

- Must make all assumptions explicit so that they can be challenged and modified if necessary
- This system is intended to cover both water quality and water quantity monitoring and assessment.
- The $100K for developing the process, would be to establish a model like MUSIC or to develop a separate system that could be used by Council.
- The $105K for initialising data collection would for the purchase of equipment (autosamplers, etc), selection of appropriate sampling locations, and design of sampling programme.
- The $150K for undertaking the sampling annually would be for cost of sample analysis and analysis of results.
- The output from the programme should be linked back to the Stormwater Management Plan.

5.2.2 Ensure beaches meet primary water contact requirements

Monitoring at bathing beaches to record levels of faecal coliforms currently costs Council $18,000 per annum. This expenditure should continue as a first priority investment to warn bathers of any potential health hazard. The lakes beaches (including some river locations) can suffer from increased faecal coliform concentrations, and at times these can be sufficiently high to fail recreational water quality standards. A relatively minor allocation of mostly "new" money is proposed under the plan to solve the faecal coliform problem at these beaches.

It is not sufficient to continue to monitor the existence of the problem without identifying the cause and if possible implementing a solution. To this end, "new" funds would be applied under the plan to firstly identify where the faecal coliforms are coming from (human or animal sources) and then measure how faecal coliforms change throughout the lakes at different times. Once this is identified, it will be easier to identify sources throughout the lakes and propose measures to reduce concentrations.

Ensure beaches meet primary water contact requirements (PP10)

Benefits of meeting the target	Risks of doing nothing	EMS Issues Addressed	Fixing a symptom/cause or providing an enhancement?
Healthier swimming conditions in the lakes	Recreational swimming spots unsuitable for swimming at certain times	Main Issue: (WH1) Sources of pathogens and faecal coliforms in the rivers and estuaries are not well understood Other Issues: WH4	Symptom

Proposed actions:

Action	Comments	Cost			Responsibility	Implementation		Priority
		Start-up	Implement.	Ongoing		Location	Timeframe	
10.1 Revise the existing programme to inform management while ensuring it continues to meet statutory requirements	Existing programme should be restructured to improve understanding of how faecal coliforms vary in space and time.		$5,000	$15,000	**WSC**	Lakes beaches	Yr 1 – 5	1 – Keystone
10.2 Resolve question about faecal sources in the estuary		$1,000	$70,000		**WSC**	Estuary wide	Yr 1	1 – Urgent
10.3 Target and fix sources as needed	May include dispersing sources (e.g. if bird related, consider discouraging congregations near swimming areas)	$5,000		$50,000	**WSC**	Lakes beaches	Yrs 2 - 5	2 – Implementation

Evaluation and Management

- Look to recreational water quality locations – the object of any evaluation would be to see an improvement in conditions over time
- Work within existing recreational guidelines (NHMRC)
- Isolate individual sources of faecal coliforms (birds, human, dogs etc)

Reporting

- If possible tie to DEC's Beachwatch programme
- SOE, Newspaper (as with current programme)
- Liaise with the Technical Advisory Panel

Funding

- Beachwatch?
- H-CRCMA funding may not be available

Supporting Information

- The existing programme is thought to be measuring all faecals and not discriminating between sources which makes it difficult to provide solutions
- Need to define and locate individual sources so that loads can be reduced to healthier levels
- The $50,000 budget to target and fix sources of faecal coliforms is intended to be used to mitigate priority sources.
- This may mean in some years the budget is directed to sources of sewage, and in other years used to address sources in runoff (from pet exercise areas etc).

5.2.3 Stabilise foreshore and streambank erosion

The primary watercourses draining into the Tuggerah Lakes are Saltwater, Tumbi, Ourimbah, Wyong and Wallarah/Spring creeks. The lower sections of each comprise part of the estuary and the upper reaches convey freshwater and sediment from the catchment to the estuary.

All of these streams have bank erosion and vegetation degradation problems that facilitate the erosion of nutrient rich sediments from their margins during floods (Figures 22 & 23). These sediment loads not only silt up the estuary, they also supply unnaturally high amounts of nutrients during wet periods that could potentially be sufficient to tip the estuary back towards a eutrophic state in a wet year. Streambanks are also of value to catchment ecology through provision of green corridors through the landscape connecting upper and lower catchment populations of flora and fauna. Because of its significant contribution to water quality in the Lakes system, including the creeks, this is an area where Council already makes a small financial contribution of $0.18 million per annum.

Given the severity of the threat posed by this problem, a substantial increase in the funding already allocated by Council is proposed under the plan. This action is considered a high priority because of the positive impact that remedial work can have on the fundamental problem of water quality, as well as on the ecology of rivers and creeks.

Initial action will involve a review of the status of the banks of all tributary creeks and production of a prioritised programme of measures deemed necessary to reduce bank erosion and nutrient supply to the Lakes. An ongoing maintenance regime would also need to be developed as part of the programme.

Achievement of positive outcomes will involve both revegetation initiatives, physical armouring works in rare circumstances, exclusion of stock through negotiated arrangements with landholders, and limiting boat wash in the navigable areas of these creeks. Arguments that creek bank works do not form part of estuarine management should be clearly rejected on the basis of the needs of the estuary.

Stream bank rehabilitation is the responsibility of the Department of Natural Resources, Council and the Catchment Management Authority working in partnership with private landholders and community groups. It is therefore an area where Council should use its financial contributions to direct the focus of those agencies to sites where works maximise positive impact on water quality. Bush regeneration through contractors and bushcare groups are effective methods to address these issues.

Figure 22. Streambank erosion before rehabilitation.

Figure 23. Streambank after rehabilitation.

Stabilise foreshores and streambank erosion (PP1)

Benefits of meeting the target	Risks of doing nothing	EMS Issues Addressed	Fixing a symptom/cause or providing an enhancement?
Keeps sediment loads in check and protects riparian habitat	Increased turbidity, smothering of habitat on the bed of the lakes and rivers, degradation of riparian habitat	Foreshore and streambank erosion adds sediment to waterways (WE7, VR3)	Cause

Proposed actions:

Action	Comments	Cost			Responsibility	Implementation		Priority
		Start-up	Implement.	Ongoing		Location	Timeframe	
1.1 Prepare creek management plans and identify areas experiencing poor creek condition or streambank erosion (including urban streams)	A number of stakeholders/agencies have some plans in place (e.g. H-CRCMA/DNR above the weirs) but nothing that identifies the need for the whole catchment/estuary. Consider an initial desktop review to minimise costs.		$300,000		**WSC**, Water Authority, DNR, H-CRCMA	Catchment	Yr 1	1 – Efficient planning
1.2 Develop a programme of prioritised remediation measures	This could be done as part of 1.1. All stakeholders should be consulted, taking care to identify areas of cultural significance.	$50,000	$100,000		**WSC**, Water Authority, DNR, H-CRCMA	Catchment	Yr 1	1 - Keystone
1.3 Implement rehabilitation works including bank stabilisation, bush regeneration and limiting stock access/boat wash.	This can be started in Year 1 for locations in Wyong River, Ourimbah Creek, Tumbi Creek, Saltwater Creek and Wallarah/Spring Creek. Make funds available to landholders.			$500,000	**WSC**, Water Authority, DNR, Landcare	Creeks	Yr 1	1 - Urgent
1.4 Assess effectiveness of rehabilitation, collate data, present to stakeholders and inform management	Some “before” assessments may be required, but the comparison should wait until rehabilitation has established.			$50,000	**WSC**, Water Authority, DNR, H-CRCMA	Rehabilitation sites	Yrs 3-5	3 – Checking

Evaluation and Management

- Make the conceptual model for decision-making explicit
- Evaluation of this target could be undertaken at both a management level (e.g. x km or rehab per year) or at a physical level where estimates of erosion pre- and post-rehab could be used to define tonnes of sediment that are no longer entering creeks/estuary. Evaluation post-rehab should include visiting previous rehab sites to learn of success/failures.
- Consider using the “Water Action Team” to work on developing targets and setting appropriate priorities. If such a team is not used, a working group should be established to assist with this process.

Reporting

- Stakeholders through working groups, SOE, Landholders via mailouts/newsletters, Stormwater Management Plan (for urban streams)
- Successes and failures must be discussed and shared.

Funding

- Opportunities include the H-CRCMA’s River/Land programs and the Commonwealth Water Fund (particularly within the Water Supply Catchment)
- Landcare groups could undertake significant components of work and attract grant funding/sponsorship

Supporting Information

- Estimated length of streambank that require high priority rehabilitation is approximately 100km. Costs for rehabilitation vary, but are of the order of 100’s of dollars per metre. An approximation is $500/m. Cost to remediate all priority sites = $50 million. Given the size of the task, it is important to prioritise the way the works are carried out. A minimum of 1km of critical streambank should be rehabilitated per year @ $500 per metre.
- Link to dredging programme for rivers to assess long term improvements in the amount of sediment introduced to the creeks and then the estuary.
- Creek management plans should be prepared for Saltwater, Tumbi, Ourimbah, Wyong and Wallarah creeks. A separate urban creek management plan should also be developed.
- The assessment of rehabilitation effectiveness could be undertaken as part of a co-operative programme with community groups and stakeholders.
- Consider implementing a policy that reinforces the protection of streams for environmental purposes.
- The $300,000 is to produce creek management plans for each creek and an urban creek rehabilitation plan ($50,000 each plan).
- The $50,000 start up for the programming of remediation is for approvals and permits. The $100,000 is developing the detailed designs for each site and scheduling the work amongst the creeks.
- The $50,000 review costs are large to cover the cost of reviewing management across a wide area and then reporting it back to key Council documents.

5.2.4 Encourage sustainable use of water

The Tuggerah Lakes estuary receives surface water from natural waterways and stormwater networks. The natural waterways have come under increasing pressure from landuse activities including intensive agriculture, forestry and residential development. Water extraction to support agriculture and the water supply, has reduced the amount of flow from the less developed upper catchment to the estuary (Figure 24). Stormwater networks have expanded to collect water from new developments in the catchment. Generally cleaner water (in low flows) from the upper catchment has been removed from the supply to the estuary and is replaced by more intermittent polluted water from the heavily developed lower catchment. Increasing stormwater reuse and detention minimises the impact that stormwater flow can have on the estuary and reduces demand on the existing water supply. To this end it is proposed that "new" funds be allocated under the plan to assist in pursuit of this initiative. This is primarily a responsibility of the Joint Water Authority and Council should encourage positive action under the Estuary Management Plan.

Figure 24. Mangrove Dam - water supply for Gosford and Wyong.

Reduce demand for river water that flows to the lake, by encouraging sustainable use of water in the community (PP27)

Benefits of meeting the target	Risks of doing nothing	EMS Issues Addressed	Fixing a symptom/cause or providing an enhancement?
Current flow patterns to the estuary maintained for longer (or potentially increased)	Increased demand for water may see more water taken from rivers meaning less flowing to the estuary	Increasing population puts an increased demand on water supply (WS1)	Cause

Proposed actions:

Action	Comments	Cost			Responsibility	Implementation		Priority
		Start-up	Implement.	Ongoing		Location	Timeframe	
27.1 Review of innovative schemes and current best practice	There are opportunities for reducing demand across the catchment, through BASIX and integrated water cycle management in new development.		$20,000		**WSC, Water Authority**	Catchment	Yr 1	1 – Keystone
27.2 Conduct trials of incentive schemes	Incentive schemes in existing areas could reduce current demand (water tanks, grey water connections, low water gardens).			$50,000	**WSC, Water Authority**	Catchment	Yr 2 – 3	2 – Implementation
27.3 Implementation of successful trial	Some sporting clubs have already implemented demand reduction programmes.	$25,000		$200,000	**WSC, Water Authority**	Catchment	Yr 4 – 5	2 - Implementation
27.4 Review community acceptance, cost impacts and demand changes	Cost/benefit and ecological impacts would need to be carefully considered			$10,000	**WSC, Water Authority**	Catchment	Yr 5	3 – Checking

Evaluation and Management

- This programme is important for the estuary because reduced demand for water may ultimately allow for more environmental flow to the estuary from the rivers.
- The Water Authority is already examining measures as part of normal operating practice – it may wish to take the lead on this project.
- This is a rapidly evolving field and requires constant revision.
- It is important to consider the impact of stormwater harvesting which is being considered as part of new developments. This can remove water from a sub-catchment water cycle (rather than redistributing it from infiltration to surface water when the catchment becomes developed).

Reporting

- The success of this programme should be reported through the same mechanisms as the Water Authority operations.
- Councils Management Plan, SOE

Funding

- Water Fund
- H-CRCMA programmes

Supporting Information

- The $25,000 is to go toward the implementation of any successful trial as it would likely require a number of permits and changes to operational budgets and policies before being initiated.
- The costs associated with incentives depends very much on the scope and scale (could be as little as offering discounts on organic gardening books, or as much as rebates on water rates) - $200,000 is the best initial estimate.

Figure 25. Map showing locations of Water Quality programmes

5.3 Implementing this action plan

5.3.1 Budget

The current Council expenditure on water quality improvement activities is approximately $870,000 p.a. This Action Plan identifies approximately $3.1 million of annual water quality improvement funds, which means approximately **$2.3 million p.a. of new funds** is required.

5.3.2 Assigning Priorities

The priority programmes under this action plan are all important. Their relative priority is very difficult to judge and will change depending on current knowledge, available budget etc. As such, an assumption has been made that their relative priority should be equal. However, priorities have been assigned within each priority programme to guide Council as to which action should be implemented first and why. These are ranked from 1 (most important/urgent) to 3 (least important/urgent).

5.3.3 Agreeing to responsibilities

An important part of working with stakeholders is reaching agreement on which organisation has responsibility for implementing the various actions. As the largest land manager in the catchment, it is expected that Council will assume responsibility for a significant number of the actions in the water quality plan.

5.3.4 Liasing with affected residents/stakeholders

When works are proposed as part of this action plan, affected residents, businesses and stakeholders should be involved at the earliest opportunity. This will ensure that local knowledge is made available to the design process, and that affected parties have every opportunity to provide comment on actions that impact on them.

5.4 Reviewing and adapting

5.4.1 Review

This action plan should be reviewed in time for the budget planning process that precedes each financial year. The review should focus on:

- Management and Ecological targets met
- How much of the budget was spent
- Whether projects succeeded or failed and the lessons learnt
- Government changes, new funding opportunities, latest research
- Prioritising and budgeting next years work

5.4.2 Reporting

It is important that the success of these programmes be reported back to Council, appropriate agencies, organisations part funding the programmes, and most importantly the community. In terms of linking with key documents, it is recommended that Council's Management Plan reflect these action plans as the primary vehicles for delivering estuarine management outcomes on a year-by-year basis, guided by the 5-yr Estuary Management Plan.