



Shoalhaven River Estuary Management Plan

Adopted March 2008

Using this Document

The Shoalhaven River Estuary Management Plan presents both a recommended suite of actions for the future sustainable management of the estuary and a detailed explanation of how these actions have been selected.

An extended Executive Summary provides an overview of the issues that have been considered and the analysis that has been conducted, together with maps showing important actions.

The main text of the document has four parts:

Part 1: Scope and Framework

This part of the Plan describes the study area and identifies the parties that have responsibilities for aspects of estuary management. Part 1 also shows how the Estuary Management Plan relates to the regional context of natural resource management, provided by the Catchment Action Plan. Part 1 establishes four major management themes for sustaining the estuary:

- Management Integration and Co-operation;
- Morphodynamics;
- Biodiversity; and
- Productivity and Community Enjoyment.

Part 2: Components of Sustainable Estuary Management

Part 2 develops and explains the method for determining which of many possible issues and options are important for the future health of the waterway and to protect the lifestyle of local communities. It provides detailed analysis of natural, social, cultural and economic values of the estuary and of the various hazards and threats which affect these values. Part 2 sets out a comprehensive suite of objectives for the future management of the estuary and discusses how the relative importance of objectives varies with management orientation for different parts of the system (a balance in favour of conservation of natural values or in favour of social and economic values).

Part 2 also presents the method and results of a qualitative risk assessment of threats to all aspects of estuary sustainability. The results of this risk assessment are a key part of the justification of proposed management responses.

Part 3: Estuary Management Options and Evaluation

Part 3 presents the benefits and problems associated with a wide range of possible management actions for the Shoalhaven River estuary, to differentiate the most effective suite of actions for estuary sustainability. Part 3 also provides additional location or method information for important actions and attributes priority.

Part 4: Plan Implementation

Part 4 shows how the recommended actions for each part of the large estuary fit together, within the Principal Management Orientation for these management zones.

Part 4 also discusses how these preferred suites of actions will be implemented. It provides information about required investment and sources of funding. It discusses partnerships between Council, State Government agencies and the local community to deliver important actions, and establishes reporting avenues that will ensure that communities have access to information about what has been done and what has been achieved.

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APPENDICES

1	Qualitative Risk Assessment
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GLOSSARY

Information about the terms used in this document is provided below.

Abbreviations: A quick checklist of abbreviations for organisations referred to in this document:

SCC	Shoalhaven City Council
DNR	Department of Natural Resources (now part of DECC and DWE)
DEC	Department of Environment and Conservation (now part of DECC)
DPI	Department of Primary Industries
DoP	Department of Planning
SRCMA	Southern Rivers Catchment Management Authority
DEH	Department of Environment and Heritage
MPA	Marine Parks Authority
SCA	Sydney Catchment Authority
NSWMA	NSW Maritime Authority
DWE	Department of Water and Energy
DECC	Department of Environment and Climate Change

Acceptable and unacceptable risks: Acceptable risk refers to a level of risk at which communities decide that further restricting or altering an activity is not worthwhile. Usually this is because the changes will not significantly reduce the risk, or because the expenditure (or other costs) is not considered worthwhile. Conversely, unacceptable risks are those which the community will not tolerate under any circumstances. In between these two are tolerable risks. These are not necessarily negligible risks, but communities recognise that there are trade-off benefits. Tolerable risks can be reviewed and reduced when opportunities arise.

Acid Sulfate Soils:(ASS): Soils (or sediments) that contain the sulfidic mineral pyrite. They are common in estuaries and on coastal floodplains where deposition has occurred in tidal environments. If the pyrite is exposed to the air and oxidises, it produces sulphuric acid. The oxidation of these soils can reduce the pH of estuary waters to 3-4, well below the acceptable level for healthy fish. Oxidised acid sulfate soils also cause scalding of pasture.

AEP (Annual Exceedence Probability): Design storms for modelling of hazards are often specified in terms of AEP, for instance, the 5% storm event is the storm which has a 5% chance of occurring in any year (i.e. five such storms could occur, on average, in 100 years). A 5% AEP is equivalent to a 20 year ARI.

Aquatic habitat: Habitats that occur in fresh, estuarine and marine waters. In estuaries, aquatic habitat refers to seagrass, mangrove and saltmarsh, as well as rocky substrates, sandy substrates and mud basins.

ARI storms/flood events: Average Recurrence Interval. The average interval in years between the occurrence of a flow, discharge or rainfall greater than, or equal to, a specified amount.

Biodiversity: The diversity of life forms at all levels of biological organisation. It can include genetic diversity, species diversity, habitat diversity and ecosystem diversity. Maintenance of biodiversity is one of the key principles of ecologically sustainable development.

Catchment Action Plan (CAP): The CAP was prepared by the Southern Rivers Catchment Management Authority and is the natural resources action plan for the south eastern part of NSW. It sets out overall natural resource management objectives and targets for the region and identifies priority management programs.

Climate change: Long term patterns and trends in temperature, rainfall and storminess, usually on a time scale of centuries or more. Shorter term variability (droughts and floods) is superimposed on these longer cycles. Sea level rise is a consequence of global warming, one aspect of climate change. Note that sea level can also rise due to fluctuations in surface pressure and because of tectonic processes.

Comprehensive Coastal Assessment: Part of the NSW Government response to increasing pressures on coastal environments. It includes a number of whole of coast studies, including coastal erosion risk, Aboriginal heritage and coastal lake sustainability.

Connectivity: In the context of estuarine and floodplain habitat, this refers to the continuity of habitat, and the linkages between patches of habitat (in-stream and/or terrestrial) that allow species to benefit from the entire habitat, rather than be restricted to a single small area. Connectivity is reduced by land clearing, roads and other infrastructure etc.

Costs and benefits: For sustainable estuary management, costs and benefits incorporates economic cost and profit, but also benefits or costs (losses) for natural values, cultural values and social values.

Crown Land: Crown land is land that is owned and managed by State Government. It accounts for over half of all land in New South Wales and includes: Crown lands held under lease, licence or permit; community managed reserves; lands retained in public ownership for environmental purposes; lands within the Crown public roads network; and other unallocated lands. Many non-tidal waterways across the State also comprise Crown land as do most tidal waterway lands. The bed of the Shoalhaven River estuary is Crown Land, as are parts of the bank, floodplain and headlands. Crown land may be managed by the NSW Lands Department or may be in the care and control of Council. Plans of Management are prepared to guide how significant parcels of Crown Land will be managed.

CSIRO: Australia's peak scientific research organisation. CSIRO conducts research programs across a wide range of natural resources, primary industries, energy and other fields, including a program on the potential impacts of climate change on Australian communities.

Department of Environment and Climate Change (DECC): The NSW government department that incorporates the former Environment Protection Authority (environmental standards and pollution regulation), National Parks and Wildlife Service (conservation, threatened species) and Department of Natural Resources. Administers natural resource legislation and policy, including vegetation management, soil management, catchments, floodplains, estuaries and coasts.

Department of Primary Industries (DPI): The NSW government department that administers legislation and policy relating to agriculture, fisheries, forests and mining. Part 7A of the *Fisheries Management Act 1994* outlines the threatened species provisions for "fish" (as defined by the *Fisheries Management Act*) and marine vegetation. The Fisheries Scientific Committee also has a role in the listing of aquatic Endangered Ecological Communities (EECs).

Department of Water and Energy (DWE): The NSW government department that delivers the Government's policy and reform agenda for the water and energy sectors. DWE monitors the impact of environmental flows on the Shoalhaven River.

Development Control Plan (DCP): A planning instrument used by local government to guide the type of development and land management that is permissible on land in the Council area. Used in conjunction with the Local Environmental Plan, it provides more detail about acceptable development for a specific site and/or type of development.

Diffuse source pollution: Pollution originating from a widespread area, such as urban stormwater runoff, or agricultural runoff.

Ecologically sustainable development (ESD): Development that meets the needs of the present without compromising the ability of future generations to meet their needs. There are four principles that contribute to development that is considered to be sustainable. These are intergenerational equity, conservation of biodiversity, full accounting of all costs and benefits and the precautionary principle (risk avoidance). Shoalhaven City Council is required to manage sustainably under the Local Government Act, and has prepared guidelines for the implementation of ESD in all its activities.

Ecosystem Integrity Index: A measure of the health of a natural system, based on multiple indicators. Originally developed by the CSIRO, for estuaries, the EII can include data about eutrophication, chlorophyll-a, turbidity, algal blooms, faecal coliforms, habitat loss, fish kills, invasive species etc. The Department of Natural Resources and Catchment Management Authority are refining the indicators to be used in the EII for the Shoalhaven River. An improved EII is a key target for estuary management.

Endangered Ecological Community (EEC): A vegetation community that is recognised by the NSW Scientific Committee as being very rare or vulnerable. Many of the floodplain and aquatic communities that occur in the lower Shoalhaven are identified as Endangered Ecological Communities. EECs are protected under the Threatened Species Conservation Act and the Fisheries Management Act, with specific assessment and management requirements for development applicants and land managers.

Entrance management policy or plan: Many estuaries and coastal lakes have ocean entrances that are intermittently open or closed, depending on flow and wave conditions. An entrance management policy or plan provides guidelines about the circumstances in which an estuary entrance can be artificially opened. The policy is usually based on flood risks, water quality or safety issues.

Estuary flushing: Estuaries are flushed with fresh water after major rainfall/catchment runoff events. For very large events, the fresh water may displace all of the marine water in the system, and saline conditions may not return to the upstream extremity of the estuary for many weeks.

Estuary processes: Tidal currents, fluvial flows, erosion and deposition of sediment are all physical processes that occur in estuaries. The mixing of fluvial flows and tidal flows is a distinctive feature of estuarine systems. Estuary processes also include the chemical and biological behaviour of an estuary.

Estuary values: Values are the experiences and qualities of the estuary that are important to local communities and scientists. They include features such as significant habitat, water quality, scenic landscapes, places of cultural significance to people of various ages and ethnicity in the community, recreational opportunities and lifestyle etc.

Floodplain: The generally flat land adjacent to a river estuary that is formed by the deposition of sediment by overbank fluvial flows (floods) or along migrating estuarine channels. Evidence or former channels can usually be seen in the surface of the floodplain.

Geomorphic: This refers to landscape forming processes, such as sediment transport, deposition of bars and shoals, floodplain accretion, bank erosion, channel migration, etc.

Habitat: combines features such as vegetation type and structure, soil type, presence of soil litter or tree hollows, snags in rivers etc, to provide resources for animals.

Hazards: In estuary and coastline management, this refers to physical events that affect the stability of the landscape. Examples include beach and dune erosion, geotechnical processes on cliffs, bluffs and river banks, flood scour, tidal inundation etc.

Healthy Rivers Commission (HRC): A NSW government organisation which operated for about six years in the late 1990s and early 2000s. The Commission conducted detailed studies of natural resources management for major river catchments and coastal lakes in NSW. Examples include the Shoalhaven, Clarence, Hunter and Hawkesbury Rivers. The Commission presented strong views about coordination, integration and accountability in natural resource management.

Hydrodynamics: In estuaries, hydrodynamic processes are those associated with tidal currents and fluvial flows.

Hypersaline: Having a salinity greater than seawater (i.e. above 35 parts per thousand).

Indicators: In natural resource management, an indicator is a characteristic or parameter of the natural system that can be measured to demonstrate whether investment in management has produced the desired results. Examples include aspects of water quality, trends in seagrass cover, numbers of fish kills, trends in recreational fishing effort, length of stable bank, relative abundance of weed species in EECs, etc.

Incentives: Opportunities that are provided to encourage land holders or other land managers to modify their behaviour. For instance, Council can offer rate reductions on land dedicated to private conservation; the government can provide low cost loans to assist farmers to fence high value habitat remnants; the government can provide assistance with property management plans. Incentives can also be supported by clear and consistent regulatory activity.

Local Environmental Plan (LEP): The principal planning instrument for each Local Government Area. The LEP establishes land use zones (such as 1 rural, 2a residential, 6 open space and 7 environmental protection), and sets out development that is prohibited or permissible (with or without consent) in those zones.

Lower estuary: The reaches of the estuary from Nowra Bridge to the mouth (Shoalhaven Heads and Crookhaven Heads). This area has a wide coastal floodplain.

Metropolitan Water Plan: The NSW government's plan for a sustainable water supply for Sydney. It includes dams, inter-catchment transfers (such as from the Shoalhaven), groundwater, recycled water etc.

Migratory waders: Species of water birds that travel to Australia from the northern hemisphere on a seasonal basis. Australia is a signatory to international conservation agreements to protect habitat for these birds (e.g. the China-Australia and Japan-Australia agreements). They are also protected by the Commonwealth Environment Protection and Biodiversity Conservation Act.

National Land and Water Resources Audit (NLWRA): A national assessment of natural resource condition, conducted by the CSIRO. A benchmark assessment of estuary condition was part of this audit.

Natural resources: Physical and ecological aspects of the landscape, including air quality, water flows and quality, soil character and condition, vegetation diversity and condition, scenic quality of the landscape etc.

Objectives: In natural resource planning, objectives are what the plan is trying to achieve.

pH: A measure of the acidity of substances. For healthy estuary waters, pH should be within the range 6.5 to 8.5.

Plan of Management: Most often a detailed local area plan prepared as a requirement of the Crown Lands Act, Local Government Act or National Parks and Wildlife Act (i.e. for land that is owned

by state or local government). The Plan sets out management actions and protocols to protect the important features of the land, for the benefit of the community and future generations.

Point sources: Specific locations/premises that emit or discharge pollutants. For instance, a discharge to a river from a sewerage treatment plant is a point source. The alternative is a diffuse source, for example runoff collected from a broad area, as is the case for stormwater systems.

Principal Management Orientation: A concept developed by the NSW Healthy Rivers Commission to distinguish the focus or priority for management in a coastal lake, depending on whether natural values or social/economic values are the most significant contributors to sustainability; it can also apply to parts of other systems. Options include Comprehensive Protection, Significant Protection, Healthy Modified and Targeted Repair.

Regional Strategy: The strategic plan for future settlement and development in regions of NSW, prepared by the NSW Department of Planning. A regional strategy for the south coast, including the Shoalhaven, is currently on exhibition. Each strategy is intended to identify areas suitable for urban growth, infrastructure requirements, areas which should be managed for conservation etc.

Riparian: Refers to land and habitat along stream banks.

Risk Management: A process for understanding the importance of issues affecting the environment. Environmental risk management considers threats (hazards), the probability of those events occurring and the consequences of an event, to classify significance. The assessment is most often conducted at a qualitative level for natural resource management, but is also applied quantitatively in other contexts (such as business planning).

Southern Rivers Catchment Management Authority (SRCMA): The regional level statutory body with responsibility for managing and coordinating natural resources at the catchment scale. There are thirteen CMAs in NSW. The SRCMA is responsible for involving regional communities in management of the NRM issues facing their region, and is the primary means for the delivery of funding from the NSW and Commonwealth Governments to help land managers and the community improve and restore the natural resources of the State. Key roles of the CMA include preparing a Catchment Action Plan (CAP) and managing incentive programs to implement the actions identified in the plan. The preparation of the CAP involved integrating previous work with the latest information and science and includes local knowledge. Investment strategies to implement CAP actions will aim to meet the standards and targets set by the NSW Natural Resources Commission and the funding requirements of both the NSW and Commonwealth Governments.

State Environmental Planning Policies (SEPP): State level policies that guide planning decisions, for instance, SEPP14 refers to coastal wetlands, SEPP 71 refers to the coastline, SEPP 26 refers to littoral rainforest. Some SEPPs also guide various types of residential development. Each SEPP sets out matters that must be addressed in a development application and situations when the Minister for Planning will be the determining authority.

Stormwater: Generally refers to surface runoff that is channelled in urban drainage systems (gutters etc). Urban stormwater may contain a range of pollutants (sediments, bacteria, chemicals) that reduce the quality of receiving estuarine or river water.

Sydney Catchment Authority: The State government organisation with responsibility for managing the drinking water catchments of Sydney (e.g. Warragamba).

Thalweg: The alignment of the main channel within a river or estuary.

Threatened species: Individual species of plants and animals (rather than communities) that are identified in the NSW Threatened Species Conservation Act. They are rare or vulnerable, or at the extremity of their range.

Tidal limit: The most upstream location where a tidal rise and fall of water levels is discernible. The location of the tidal limit changes with freshwater inflows and tidal range.

Tidal ventilation: The movement of tidal water into and out of a part of the estuary (e.g. a tributary creek or floodplain drain). It includes the concepts of tidal excursion (the distance travelled by a water particle between low water slack and high water slack) and tidal exchange (the proportion of the tidal prism that is flushed away and replaced with fresh coastal water each tide cycle).

Upper estuary: The reaches of the estuary upstream of Bomaderry Creek (Nowra Bridge) (Management Zones 1 and 2).

Wetlands: Freshwater or estuarine habitats that are wet for most of the time, and have plants that are adapted to wet conditions. In the Shoalhaven estuary, wetland habitats are located on the coastal floodplain (estuarine wetlands and freshwater back swamps), behind sandy coastal barriers and in low shoals and islands within the estuary (saltmarsh and mangrove).

Wetlands of National Importance: An inventory prepared by the Commonwealth government, using six physical and cultural criteria. These wetlands are documented in the "Directory of Important Wetlands of Australia". Of the 851 nationally important wetlands in Australia, in June 2002, 56 wetlands were also recognised as being "internationally important" under the Ramsar Convention List of Wetlands of International Importance.

PART 1: SCOPE AND FRAMEWORK

1.0 INTRODUCTION

This Estuary Management Plan for the Shoalhaven River Estuary presents an integrated suite of management actions to ensure that the important natural, economic and social values of the Shoalhaven River estuary and its coastal floodplain are enjoyed and protected both by current residents and visitors and by future generations.

The Estuary Management Plan provides the details of how Shoalhaven City Council, other government management partners and the community of the region propose to address issues that present risks to features of the estuarine landscape that are highly valued by the regional community.

The Estuary Management Plan is intended to be implemented in conjunction with other natural resource management plans for the river catchment and the coastline, under the strategic framework provided by the Catchment Action Plan (2005), prepared by the Southern Rivers Catchment Management Authority.

The location of the Shoalhaven River estuary and the boundaries of the study area for this project are shown in **Figure 1.1**.

1.1 WHY PREPARE AN ESTUARY MANAGEMENT PLAN?

The Shoalhaven River Estuary is one of the outstanding natural features of the NSW South Coast. The river catchment, estuary and associated coastal floodplain are significant resources for the people of the Shoalhaven Local Government Area, for the south coast generally and for the Sydney Greater Metropolitan Area. An estuary management plan is part of the package of natural resource management strategies to protect these significant values, and has the overall purpose of:

- Protecting the natural resources of the estuary;
- Establishing agreed management priorities for the estuary;
- Co-ordinating efforts by agencies and community groups in the management of the estuary; and
- Obtaining funding for implementation of important management activities.

Significant natural and community assets which are highly valued in the Shoalhaven include:

- the Shoalhaven is a rare major river estuary on the NSW south coast;
- the estuary contains one of the largest areas of saltmarsh on south coast;
- the estuary is one of very few in NSW that discharge fluvial sand into the ocean;
- the estuary includes important habitat for migratory waders and is the most important estuary on the south coast in this regard. The lower estuary, at Shoalhaven Heads and Comerong Island (including the Comerong Lagoon area) supports some 90 species of shorebirds or waders, of which 27 are subject to international agreements (DEC 1998). In addition, some 6000 swans and ducks are reported to use the estuary during the winter when very cold conditions prevail on the southern tablelands;
- the estuary and associated floodplain includes Wetlands of National Importance, such as Coomonderry Wetland;

- the Shoalhaven River water supply scheme (which operates upstream of the estuary) is important for its contribution to reliable potable water supply for Greater Metropolitan Area as well as local towns and villages;
- the Shoalhaven floodplain supports productive dairying and beef cattle industries (provide info on economic value);
- the Shoalhaven river estuary is an important commercial fishery and oyster growing area with significant areas of the lower estuary identified by the Department of Primary Industries (2006) as priority sites for high quality oyster production;
- the estuary is a major recreational resource, for boating, fishing and other passive activities for the local and regional community. Local residents value the peaceful lifestyle that the area offers;
- the scenic character of the estuary, in both the upper gorge section and the lower floodplain section, is a highly valued landscape for local people and is also a significant attractor of tourists;
- the estuarine floodplain and headland areas include Indigenous Places of National Significance;
- the Shoalhaven floodplain was settled in the early to mid nineteenth century and there are historic settlements, at Bundanon, Terara and Coolangatta, of National heritage significance, from artistic and agricultural perspectives; and
- Nowra/Bomaderry, on either side of the Shoalhaven River estuary as it emerges from the gorge country of the upper estuary, is proposed as a major growth centre in South Coast Regional Planning Strategy, building on existing infrastructure and community services at Nowra/Bomaderry.

The character and associated value of the Shoalhaven River estuary and its coastal floodplain are not static; indeed there is abundant geomorphic evidence that this is a highly variable and dynamic system. Whilst Council acknowledges that diversity and change are inevitable and often positive, many of the values of the Shoalhaven River estuary are considered to be vulnerable to significant change or degradation. This means that the value may be readily transformed or degraded by natural processes, by long term process changes that are driven by human intervention (such as entrance training works or bank erosion structures) or by the direct and indirect impacts of development activity (such as boating, or agriculture). The magnitude or rate of change may not be acceptable to the community.

The diversity of highly valued natural and community assets, the desire to secure natural and social values for future generations, and the vulnerability of these assets to ongoing landscape processes and development pressures are key drivers for the preparation of a strategic plan for the estuary. The preparation of an integrated natural resource management plan for the Shoalhaven River estuary and its floodplain was strongly recommended by the Healthy Rivers Commission (1999) and was a commitment of the then Department of Land and Water Conservation in the Government's Statement of Intent (2001). Apart from addressing specific natural resource management issues such as acid sulfate soils, floodgate management, entrance management, bank erosion and loss of riparian habitat, the HRC recommendations focused strongly on the role of the Estuary Management Plan as a tool to inform and guide local and regional statutory land use planning.

The preparation of an Estuary Management Plan for the Shoalhaven River estuary was also identified as a priority action in the Southern Catchment Blueprint (2002) and is reinforced in the Catchment Action Plan (2005) prepared by the Southern Rivers Catchment Management Authority.

The Estuary Management Plan provides a strategy for local implementation of the standards and targets established by the NSW Natural Resources Commission and subregional targets established in the Southern Rivers Catchment Action Plan. It establishes a management framework that will deliver improvements in the Ecosystem Integrity Index for the Shoalhaven River estuary (National Land and Water Resources Audit) (see **Section 3.2** for details).

Shoalhaven City Council originally resolved to prepare an Estuary Management Plan for the Shoalhaven River estuary in 1999. Several technical studies of estuary hydrodynamics have been completed. Following State Government investment in critical ecological benchmarking in the Shoalhaven, an increased strategic importance of the Shoalhaven River for regional water supply and the identification of the Shoalhaven Local Government Area as a growth area within the State's overall planning framework, Council has reviewed the scope of the Estuary Management Plan. An updated Estuary Data Compilation Study (Umwelt 2005), which details the previous studies of the estuary, was recently completed.

With joint investment from the Department of Natural Resources, Council is now in a position to complete the preparation of the Estuary Management Plan, providing an integrated and strategic natural resource management plan to guide and complement new land use planning strategies and water management strategies.

In this context, the purposes of the Shoalhaven River Estuary Management Plan are therefore:

- to clearly identify the values of the estuary that are critical factors in long term natural resource conservation, land use and settlement planning;
- to develop a management strategy for the estuary that is consistent with the philosophy of other natural resource management planning for the Shoalhaven catchment and South Coast region;
- to inform the development of a new Local Environmental Plan for Shoalhaven City Council;
- to provide guidance for the integrated management of the estuary and associated coastal floodplain;
- to share with local stakeholders varying perspectives on estuary and coastal floodplain management issues and to enhance awareness of how estuary processes and values interact;
- to demonstrate that the proposed management strategies take into consideration the views and values of local community stakeholders, including people of different ages, occupation and ethnicity. In particular, the plan must respect the values of local Indigenous people;
- to establish a management framework that engenders confidence in the local community that major natural resource issues associated with the estuary and coastal floodplain are understood, and that decisions have been made in a rational and repeatable manner; and
- to provide the basis for funding decisions and management partnerships so that key management actions can be implemented.

The steps in the preparation of an Estuary Management Plan are set out in the NSW Estuary Management Manual (1992). Although the process followed in the Shoalhaven varies from the original concept, all of the same information has been included, in specialist technical studies (geomorphology, bank erosion and ecological benchmarking), in the work of the Healthy Rivers Commission, in the preparation of two Data Compilation Studies (1999 and updated in 2005 to include a full review of all current process and planning information).

Council's compliance with the overall Estuary Management Plan process is shown below.

1. **Establish an Estuary Management Committee.** Council has had several Estuary Task Forces for parts of the City for many years. Council restructured all its natural resource management consultative committees/task forces in 2004. The Shoalhaven River Natural Resources and Floodplain Management Committee (SRNRFMC) is the group with interests in the Shoalhaven River estuary (i.e. the Estuary Management Committee). ↓
2. **Assemble existing data.** As noted above, Council prepared an initial data compilation study in 1999, and prepared a comprehensive update, including review of multiple new technical and planning studies, policies and plans, in 2005. ↓
3. **Estuary Process Study.** Council has not prepared an Estuary Process Study. It was agreed with the Department of Environment and Climate Change (DECC) that this would not be necessary, providing the Data Compilation Study provided review and analysis of multiple technical studies that had been completed. The Shoalhaven River and estuary is one of the more carefully studied systems in NSW because of the importance of the catchment for Sydney's water supply and its significance amongst south coast estuaries. Detailed technical and planning studies have recently been prepared for bank erosion (Patterson Britton 2004), wetlands, endangered ecological communities (DEC 2004), aquatic habitat (DPI 2004), river flows (SCA ongoing) etc. ↓
4. **Estuary Management Study.** Council has not prepared a separate Estuary Management Study. As with the Estuary Process Study, DECC agreed that a detailed and separate Estuary Management Study would not be necessary for the Shoalhaven estuary, because of the amount of previous work on key issues and actions. Apart from the work of the Healthy Rivers Commission (1999) there have been specific studies on recreational facilities (e.g. Webb McKeown 2004), and Aboriginal cultural heritage (e.g. Waters et al 2005). Although an Estuary Management Study has not been prepared, the Data Compilation Study (2005) and this Estuary Management Plan provide information about management issues and objectives; criteria for evaluating significance, alternative management approaches for each part of the estuary and decision making processes, as well as recommending a preferred strategic approach. ↓
5. **Estuary Management Plan.** This plan contains all the information required to justify decisions about future sustainable management of the estuary, leading to a prioritised schedule of actions and responsibilities. ↓
6. **Exhibition and Review of the draft Estuary Management Plan,** prior to finalisation. This allows the community, council and government agencies to comment on the integrated management approach. This draft Estuary management Plan will be exhibited and reviewed prior to finalisation. ↓
7. **Adoption and implementation.** The Plan describes a suite of actions, who will be responsible for implementation and the time frames for implementation. It provides an indication of the resources to be invested in each action, and details how progress will be monitored, reviewed and reported. The draft Estuary Management Plan was developed with input from the Government agencies (including local government) that will have responsibilities to implement the plan. ↓
8. **Monitor and review.** After implementation commences, Council and the State agencies will continue to review progress (actions and outcomes) and report on both achievements and matters which require a change of strategy.

2.0 SCOPE AND KEY CONCEPTS

This section identifies the individuals and organisations that have interests in the management of the Shoalhaven River estuary, as well as the overlap and interaction of these interests and responsibilities. It also provides definitions of some important terms and concepts that make up the management approach developed further in other sections.

The Estuary Management Plan considers issues and solutions on a thematic basis for the system as a whole. It also delivers local, place based suites of actions, which provide consistent management for parts of the estuary that are distinguished by the community.

The intent is to manage the estuary to best maintain the overall value of the system (taking into account natural, social, cultural and economic values), but to also recognise the special character of local areas, (e.g. for conservation, or recreation or aquaculture), to ensure the correct balance of values for sustainability at the local level.

2.1 SHARED MANAGEMENT RESPONSIBILITIES

Shoalhaven City Council has a central role in the management of the estuary, with responsibilities across diverse aspects of the waterway and its floodplain. Key responsibilities include:

- local land use planning through the preparation and implementation of a Local Environmental Plan, Development Control Plans and associated policies and guidelines;
- contribution of local perspectives to regional scale land use and natural resource management planning, such as Catchment Action Plan (currently in draft form, awaiting Ministerial endorsement) and Regional Planning Strategies;
- provision of water supply, drainage, stormwater and sewerage services for residents and visitors to the City;
- regulation of local scale pollution sources;
- preparation and implementation of an entrance management policy for Shoalhaven Heads;
- recognition and management of flooding risks;
- provision and maintenance of recreational facilities around the shoreline of the estuary, including boat ramps, public wharves, picnic areas and associated facilities;
- management of Crown Land under Council's care and control and Community Land on the foreshore, addressing both conservation issues (biodiversity, visual and cultural heritage) and community recreation;
- vegetation management, with particular attention to noxious weeds on river banks;
- support for local community initiatives contributing to the management of the estuary (special events and ongoing community projects);
- preparation and distribution of community information about the values of the estuary and approaches to value management;

- promoting protection of the cultural heritage of the area;
- support for economic activity that depends on the values and resources of a healthy estuary, including primary industry and the tourist industry; and
- showing leadership on sustainable management of the estuary in its regional and local government area context.

The Estuary Management Plan provides guidance in relation to all of these matters. Whilst Council has a primary role in these matters, it shares interests and responsibility with multiple other stakeholders, including:

- Department of Planning (DoP);
- Department of Environment and Climate Change (DECC);
- Department of Lands (NSW Lands);
- NSW Maritime Authority (NSWMA);
- Department of Primary Industries (DPI);
- Sydney Catchment Authority (SCA);
- Southern Rivers Catchment Management Authority (SRCMA);
- Department of Water and Energy (DWE)
- Commonwealth Department of Environment and Heritage (DEH);
- local residents and businesses, including community and business organisations (sporting groups, conservation groups, Chambers of Commerce, tourism organisations);
- Local Aboriginal Land Councils and Traditional Owners groups;
- research organisations; and
- visitors to the area.

Whilst the interests of these organisations and individuals overlap, they may have quite different perspectives on, and objectives for, the sustainable management of the estuary. **Table 2.1** summarises the statutory and policy requirements of each of the relevant State and Commonwealth agencies/authorities that are relevant to the development of integrated estuary management objectives and strategies. As noted earlier, local communities may also have preferences about the priority attached to specific values, or their tolerance of threats and risks to these values.

A principal task of the Estuary Management Plan therefore, is to foster shared understanding of estuary values, appropriate management objectives and achievable implementation activities, by facilitating inclusive communication across all government, community and business sectors.

Table 2.1 - Inter Agency Statutory and Policy Requirements

Agency	Key policies and legislation	Comments
Shoalhaven City Council	Local Government Act. LEP and DCP(s). Nowra Bomaderry Structure Plan. ESD Guidelines. Landscape Guidelines. Wharves and Jetties Policy. Guidelines for maintenance of oyster leases DCP 62 Residential Development in Foreshore Areas. Generic Plans of Management for Community Land. Plan of Management Greys Beach and The Grotto. Icon Park Policy. Foreshore Reserves Policy. Playground Strategy Review. Tree Management Policy. Community Participation Policy.	The range of Policies, Guidelines and Plans is indicative of the scope of Council's interest in sustainable management of natural resources and other values in the City, but this policy coverage is not necessarily reflected in the resources that Council has available for investing in management activities. E.g. Council's Foreshore Policy provides a comprehensive suite of policies for all aspects of foreshore reserves.
Department of Planning	Environmental Planning and Assessment Act. NSW Coastal Policy. SEPP71. SEPP14. South Coast Regional Strategy (draft). Comprehensive Coastal Assessment.	Responsible for setting the overall framework for land use and regional growth through regional planning strategies. Review of Council's LEP to be consistent with Regional Strategy and agreed environmental performance. Assessment of major development (Part 3A). Regulation of land use in specific sensitive environments such as wetlands and coastal zone.
Department of Water and Energy	Water Management Act.	DWE is responsible for regulating activities such as water sharing and foreshore activities involving excavation. DWE is responsible for monitoring the environmental flows released from Tallowa Dam.

Table 2.1 - Inter Agency Statutory and Policy Requirements (cont.)

Agency	Key policies and legislation	Comments
Department of Environment and Climate Change	Coastal Protection Act. Estuary Management Policy. Coastline Hazard Policy. Flood Prone Land Policy National Parks and Wildlife Act. Threatened Species Conservation Act. Protection of the Environment Operations (POEO) Act. Plans of Management for Nature Reserves (Coomonderry Swamp, Brundee Swamp and Saltwater Swamp).	HRC specifically noted the role of DECC in assisting Council with the preparation of the Estuary Management Plan (also addressing the floodplain) and an Entrance Management Policy. DECC administers the Estuary Management Program, Coastline Hazard Program and the Floodplain Management Program, which provide guidance on planning for estuaries, coastlines and floodplains. DECC administers funds to assist the implementation of Management Plans prepared under these programs. Also responsible for research and protection of both natural ecological values (water quality, threatened species and endangered ecological communities) and Indigenous cultural heritage values, both within National Park estate and on other land. DECC also regulates major industry. The POEO Act and related policy documents set discharge standards to protect the values of receiving waters (e.g. for protection of aquatic ecosystems, or for primary or secondary contact recreation).
Southern Rivers Catchment Management Authority	Catchment Action Plan for years 2006- 2016 (after endorsement by the Minister for Natural Resources). Catchment Management Authorities Act 2003. Native Vegetation Act 2003. Natural Resource Commission Act.	Specific functions of the SRCMA can be described under five main headings – planning and investment, native vegetation, water, on-ground works and community engagement. The SRCMA focuses on funding for on the ground works to make a difference where resources allow. Priorities include riverbank fencing to exclude cattle from riparian plant communities and to protect water quality, removal of fish barriers, protection of priority erosion sites and acid sulfate soil management. The SRCMA manages Property Vegetation Plans (PVPs for land clearing consents). The Natural Resources Commission has identified consistent standards and targets for catchment, estuary and

		coastline management across NSW (see Section 3.2).
Sydney Catchment Authority	Metropolitan Water Plan	Responsible for providing sustainable supply to residents of Sydney, Illawarra, Shoalhaven and Southern Highlands. SCA has particular interests in communicating the significance of environmental flow impacts on the upper estuary that may be associated with changes to water extraction protocols in the catchment. (Options for flow transfers from the Shoalhaven to the Hawkesbury system in intermediate flow conditions) are being considered). Community Reference Group is chaired by SRCMA.

Table 2.1 - Inter Agency Statutory and Policy Requirements (cont.)

Agency	Key policies and legislation	Comments
NSW Maritime Authority	Boating Management Plan (in preparation). Identified by HRC as responsibility of NSW Maritime, in consultation with DPI, council and local community.	Responsible for managing and regulating the safety and environmental performance of waterway users (commercial and recreational), including suitability of ramps and jetties, boat speeds, wake creation, fuel management and pump-out management.
Department of Primary Industries	Fisheries Management Act and Regulations. Estuary General Fishery Management Strategy. Recreational Fishing Strategy (in preparation). Indigenous Fisheries Strategy.	Responsible for regulation of commercial and recreational fishing and oystering in the estuary, but also for documentation and protection of fishery habitat – seagrass, saltmarsh and mangrove communities, etc. Part 7A of the fisheries Management Act (1994) outlines the threatened species provisions for fish and marine vegetation (EECs).
NSW Lands Department	Crown Lands Act. Plans of Management for Crown Reserves (e.g. Crookhaven Headland). Aboriginal Land Rights Act.	Owns the bed of the estuary and manages the tenure data for the entire study area. Responsible for sustainable management of Crown Land, including suitability assessments and Plans of Management.

Deleted: Department of Environment and Conservation ... [1]

Table 2.1 - Inter Agency Statutory and Policy Requirements (cont.)

Agency	Key policies and legislation	Comments
Commonwealth Department of Environment and Heritage	Environment Protection and Biodiversity Conservation Act (EPBC Act).	There are large numbers of migratory waders occupying the lower Shoalhaven in summer. Multiple places of Indigenous cultural heritage value and historical value are identified in the Register of the National Estate (fully registered or as Indicative Places). These factors trigger assessments under the EPBC Act for development proposals.

2.1.1 Matters to be dealt with in coastal zone management plans

The Shoalhaven River Estuary Management Plan is a natural resource management plan set within the NSW Coastal Zone. Most often, coastal Zone Management Plans have been prepared for the open ocean coast of NSW, but Estuary Management Plans can also be considered to be Coastal Zone Management Plans, and the requirements of the NSW Coastal Protection Act (1989) therefore need to be considered.

Section 55C of the NSW Coastal Protection Act (1989) sets out matters that must be addressed in a Coastal Zone Management Plan. A Coastal Zone Management Plan must make provision for:

(a) protecting and preserving beach environments and beach amenity. The Act defines “beach” as the area of unconsolidated material between the lowest limit of tidal or lake water level and the highest level reached by wave action. According to this definition, estuarine foreshores can be considered to be “beach”. It follows that for the Shoalhaven River estuary, “beach” includes the banks of the estuary that are affected by tides and waves (most likely wind waves in this system);

(b) emergency actions of the kind that may be carried out under the *State Emergency and Rescue Management Act (1989)* or otherwise, during periods of beach erosion, including the carrying out of related works, such as works for the protection of property affected or likely to be affected by beach erosion, where beach erosion occurs through storm activity or an extreme or irregular event; and

(c) ensuring continuing and undiminished public access to beaches, headlands and waterways, particularly where public access is threatened or affected by accretion.

Severe bank erosion is known to occur in the Shoalhaven River estuary, and tidal currents and wind waves are both important drivers of erosion. Flood discharges from the catchment are also very important causes of major erosion events and other natural disasters (e.g. flooding). The Estuary Management Plan (see **Sections 7 to 11**) presents diverse management actions that are intended to protect the environment of estuarine banks (i.e. riparian habitat restoration programs, and bank erosion control programs at selected sites). The Estuary Management Plan also presents multiple actions that are intended to protect the amenity of the estuarine foreshore for recreational users, from visual, safety and accessibility points of view.

Council works with NSW State Emergency Services to prepare emergency response plans for natural disasters such as severe coastal erosion, flooding and uncontrolled opening of the entrances to estuaries (including coastal lakes).

2.2 WHAT IS BEING MANAGED?

The intent of the Estuary Management Plan is to guide systematic and integrated management of natural resources in an estuarine context. The focus on integration requires careful thought about what is being managed and what will be seen as satisfactory outcomes of the management process. The following definitions are designed to clarify the conceptual approach to estuary management that is followed in this Plan. Overall, the plan presents strategies to control threats and mitigate risks to the values of the estuary, so that the net value of the natural system is maintained (or enhanced where necessary) in the long term.

- Estuary values. In a natural resource management context, the concept of “value” incorporates science, economics and community aspirations for the landscape that supports their lifestyle (see **Section 2.3**).
- Estuary processes. The character of the estuary is driven by the interaction of several dynamic natural systems, including hydrodynamics, morphology, sedimentology and ecology. A number of detailed technical studies of processes in the estuary have previously been completed, particularly in relation to bank erosion. Process studies are discussed in the Shoalhaven Estuary Data Compilation Study (Umwelt 2005).
- Threats to processes and values. Estuary processes naturally vary in intensity and location over time, and the condition of the estuary similarly varies and transforms (evolves) over time. These natural variations do not present threats to values, unless the community aspiration for estuary condition is fixed on a particular point within the natural range. However, factors such as large scale land use change, or the unexpected side effects of land or waterway use, or long term climate change may be considered to threaten the values associated with the estuarine landscape. Some of these threats are within the community’s control (such as choices about local land use and waterway use); others are long term responses to intervention in the hydrodynamics of the system (such as changes to channel character after construction of training walls); whilst others operate at a scale much larger than an individual estuarine system or community (such as climate change). These threats affect the nature of estuary processes and subsequently affect community values of the landscape.
- Assessment of risk. Risk is how a threat to values or processes is interpreted by the community (including scientific opinion and local resident opinion). The magnitude of the risk depends on the frequency/magnitude of the threat, and the values that will be impacted. For instance, a change to tidal current velocity and the location of high velocities in the channel may drive bank erosion at previously stable sites. This change may be considered as a threat to hydrodynamic processes and potentially to ecological processes. The threat will also affect community values such as recreational uses (e.g. that are dependent on low current velocities, shallow water and stable vegetated banks). The risk is heavily influenced by what will be lost (and cannot be replaced). So, for instance, the potential loss of a shallow sandy foreshore that underpins local lifestyles and attracts visitors (therefore generating employment and adding variety to daily lives) might be considered a higher risk than the loss of poor quality grazing land.

An underlying principle in these management definitions is that estuaries are dynamic natural systems. A sustainably managed natural system is rarely a static (unchanging) system. In Australia, this is particularly the case, because of the natural extremes in landscape and waterway processes. Even on the coast, where variability is less extreme than

in some inland parts of the continent, rivers systems can experience years of drought (with almost no freshwater flow into the estuary), contrasting with periods of very high rainfall when the estuary is dominated by fresh water flows and high flood currents scour banks, force channel changes and keep the ocean entrance open. In addition, some changes, both natural and induced by human intervention or activity, operate at scales that are much larger than can be controlled by local scale management decisions.

The management of the natural resources of the estuary does not occur in isolation. The Shoalhaven estuary is part of a larger natural system (broadly, the Shoalhaven River catchment) and region. The Estuary Management Plan is one of a suite of Natural Resource Management Plans for the Shoalhaven River catchment, the Shoalhaven coastline and the south coast region that has already been prepared or is in the process of preparation. For instance, Council is currently preparing a Coastline Management Plan for its 165km coastline. This Plan will complement the Shoalhaven Estuary Management Plan and other management plans for coastal lakes in the City. In turn, each of these plans is bedded in a context of state and national policy, strategy and legislation.

Subsidiary to the Shoalhaven River Estuary Management Plan are several local policies and programs to manage specific aspects of the estuary (such as an Entrance Management Policy, Foreshore Management Policy or Boating Management Plan). The relationship between the Shoalhaven Estuary Management Plan and other plans, strategies and policies is shown in **Figure 2.1**.

So what is being managed by the Estuary Management Plan? Fundamentally, the Estuary Management Plan is about living with a changing estuarine landscape, guiding decisions about the scope of acceptable change to the estuarine landscape that is valued by the community:

- understanding the nature of the dynamic estuarine system, and the extent of inherent variability;
- understanding the extent of long term adjustment to past management decisions. For instance, the estuary continues to adjust to the entrance controls (breakwalls) at Crookhaven Heads and the excavation of Berrys Canal in the nineteenth century;
- planning land use and land management so that they recognise and respect the scale of natural system change;
- being able to recognise threats that have the potential to drive the estuarine system outside its natural range of variability, such that it changes beyond return;
- assessing potential responses to those threats in terms of risk management and full cost-benefit analysis, where the costs and benefits include social, cultural and economic factors;
- developing an adaptive land management response that understands local and regional capacity to manage change – when to try to prevent or reduce the scale of change, and
- when to learn to adapt. Local policies, plans and actions give effect to the strategy established in the Estuary Management Plan.

2.3 VALUE BASED PLANNING

The Estuary Management Plan is a value based plan for natural resources. Values are those aspects and attributes of the estuary and floodplain system that are assessed as being scientifically important or are perceived by the local and regional community as being important to their lifestyle, their sense of place or their sense of community. An understanding of the values of the natural system is essential to integrated management, as value concepts frequently integrate natural, social, economic and cultural characteristics.

These values can be associated with the entire system or with specific management zones or with particular locations. The management focus for different parts of the system is tailored by considering differences in the nature and intensity of values across various management zones.

Estuary values underpin the objectives of the Estuary Management Plan (see **Section 5.0**) and the indicators of successful management (or progress towards successful, sustainable management).

Values can be considered both as absolute statements and relative statements that can be used to differentiate priorities. Examples of absolute value statements would be couched in the following terms:

I like....., I enjoy..... I appreciate..... I depend on.....or
“The value meets the criteria for State or National significance”.

Comparative statements about values can be used to help differentiate management priorities, for instance:

I value *this* more than *that* (ranking);

My enjoyment/access to *this* depends on the continuity of *that* (order or association); or

I would forego *this* to maintain *that* (offsets or trade offs).

It is possible that some natural and socio-economic values will be mutually exclusive. A key outcome for the Estuary Management Plan is to balance potentially mutually exclusive values so that the net value of the system is maintained or enhanced (restored) in the long term.

In preparing the Estuary Management Plan, the following broad categories of values have been considered:

- Natural values. These include ecology (water quality, biodiversity, Endangered Ecological Communities, threatened species), landscape (scenic diversity, rates of change or stability), scientific (examples of specific terrain, landscape processes etc).
- Economic values. This refers to those values that contribute to the employment and income generating activities of the estuary and floodplain, including specific land uses, waterway use (including aspects of water supply), infrastructure investment and return for industries such as fisheries and oyster growing and floodplain agriculture. Tourism and recreation based employment that utilises the resources of the estuary are significant aspects of economic value.
- Social values and cultural values. This group of values is based around the sense of place and cultural expression of past generations of Indigenous and non Indigenous people, as well as contemporary values such as recreational attributes, employment and lifestyle. Aspects of lifestyle values include the pace of activity, ease of access to water

based recreation and subsistence, personal attachment to a particular landscape, length of residence and stability of community.

By carefully describing the values of the estuary and floodplain it is possible to construct an image of how the community and institutional stakeholders would like the estuary to be in the future – i.e. to describe the intended outcomes of the Estuary Management Plan. These outcomes will be achieved by what the Healthy Rivers Commission (1999) referred to as actions that the plan will “give effect to”.

2.4 FOUR MAJOR MANAGEMENT THEMES

The Shoalhaven Estuary Management Plan is structured around four major management themes, each of which incorporates multiple management issues. There is considerable overlap between the processes and values that are included in each theme, and although the information about issues associated with each theme is presented separately, in fact the overriding principle of the Plan is that sustainable management depends on the integration of all four themes. The four themes have been chosen to facilitate understanding of the major factors contributing to the successful management of the estuary:

- management integration and co-operation;
- morphodynamics;
- biodiversity; and
- productivity and community enjoyment.

The management issues within each theme (see **Sections 2.4.1 to 2.4.4**) operate at various scales and have a range of distributions across the study area (e.g. some affect only one local part of the system, some affect multiple sites in the estuary, some affect the entire estuary and in some cases the Shoalhaven River estuary illustrates an issue that affects the entire NSW coastal zone).

The Estuary Management Plan presents an analysis of the values and threats involved in the full range of issues affecting the estuary and its associated coastal floodplain. In particular, the plan carefully considers the significance of risks to important estuary values as a means of determining management priorities (see **Section 4, Section 6 and Appendix 1**).

2.4.1 Management Integration and Accountability

One of the key recommendations of the Healthy Rivers Commission reports (1999) (HRC) and Statement of Intent (2000) for the Shoalhaven Catchment was the preparation of an integrated management plan for the coastal floodplain and estuary.

In particular, the HRC was concerned that the management of flood risks on the coastal floodplain and decisions about land use/land management on the floodplain should take into consideration the related estuary health risks. Two important components of delivering this integrated approach were seen to be the “explicit recognition of costs, benefits and externalities and the distribution of these across the community” and a review of current “incentives” and sanctions within various plans to provide a *consistent set of signals* to land users and land managers.

The Shoalhaven Estuary Management Plan deals with integrated decision making, consistent messages and signals across all sectors and coordination across multiple agencies and

authorities in terms of implementation (see **Section 7.0**). Objectives and indicators for integrative and cooperative management are discussed in **Section 5.3**.

2.4.2 Morphodynamics

The “morphodynamics” theme incorporates values and issues that are associated with physical processes in the estuary. It includes physical responses to variations in catchment runoff, tidal exchange and tidal flows (including current patterns and velocities), the stability of the bed and banks of the estuary, entrance management (including controlled and uncontrolled entrances), flooding risks across the estuarine floodplain and the physical affects of anticipated sea level rise.

The Data Compilation Study identified the following issues that are broadly linked under the theme of morphodynamic issues:

- Terara village, Greenwell Point and Shoalhaven Heads are flood prone (i.e. parts of these settlements are subject to inundation from various sources);
- community concern that current and future water extraction policies and rules (Sydney Catchment Authority) could be detrimental to the health of the Shoalhaven River (e.g. that the estuary is not, or will not be, flushed regularly enough);
- concerns that water quality and flooding are worsened when the Shoalhaven Heads entrance is closed;
- concerns about shoaling inside the Crookhaven Heads entrance, particularly during long dry periods when beach sediment tends to accumulate in the mouth of the estuary, rather than being flushed out. The training walls at Crookhaven Heads contribute to this process;
- bank erosion upstream of Nowra affects the health of riparian vegetation corridors and is removing productive agricultural land as well as affecting recreational access to the banks of the estuary. Severe stream bank erosion modifies restricted areas of aquatic habitat by increasing sediment load, changing shade conditions or increasing local turbidity. Some of this upper estuary bank erosion is driven by high flood flows, but in some locates, waves generated by boat wakes are contributing to or exacerbating erosion;
- bank erosion and major channel changes downstream of Nowra reduce the success of riparian zone restoration projects, affect aquatic habitat (likely to favour mangrove over other species) and remove productive agricultural land;
- in some locations, bank erosion downstream of Nowra also affects foreshore recreation land, creating safety, amenity and aesthetic issues;
- much of the structural control work that has previously been attempted to stabilise estuary banks downstream of Nowra has not been successful; and
- the potential impacts of sea level rise and increased marinisation of the estuary, for instance on bank stability and ecological habitat are not well understood but are considered to be significant in the longer term.

Objectives and indicators for the management of these morphodynamic issues are discussed in **Section 4.4**. Risks associated with these issues are assessed in **Section 6.2**. Management responses are discussed in **Section 8**.

2.4.3 Biodiversity

The “biodiversity” theme incorporates values and issues that are the result of ecological processes. Changes to ecological processes and status may be driven by physical/morphological change, or by discharges to the waterway (from agricultural, urban or industrial land uses) or by clearing or weed invasion, or by a range of other land use impacts.

Aspects of biodiversity that are considered in the estuary management plan include water quality suitable for healthy aquatic ecosystems (biological, salinity and pH (acid sulfate)), the health of the riparian corridor (terrestrial vegetation), the health and distribution of seagrass, saltmarsh, mangrove and floodplain wetland communities (and associated fauna). The Data Compilation Study identified the following issues linked under the broad theme of biodiversity:

- management of floodplain drainage system effects water quality by disturbing acid sulfate soils and ecological habitats in the lower estuary;
- acid levels in Broughton Creek and many other creeks and drains on the Shoalhaven River floodplain are often above ANZECC guidelines;
- the significance of ASS elsewhere on the floodplain (e.g. Crookhaven) has not been fully reviewed;
- point source discharges are affecting water quality in the estuary at various locations;
- stormwater discharges from Nowra/Bomaderry affect water quality in the estuary (nutrient and suspended sediment levels), as well as contributing litter;
- slightly elevated heavy metal concentrations have been detected at several locations in the estuary;
- dams and water extraction are contributing to elevated salinity levels in the upper estuary, affecting estuarine habitats, but the significance of the impact is not well documented;
- in stream structures such as Burrier Weir could affect the passage of fish in the upper estuary;
- changes to salinity gradients, nutrient status and acidity may affect habitat integrity;
- despite extensive clearing, there are large numbers of threatened species, endangered populations and Endangered Ecological Communities (EECs) in the riparian corridor and on the floodplain of the Shoalhaven River estuary. Remnant floodplain wetlands and Comerong Island are particularly important;
- the integrity of remnant vegetation in the riparian corridor is degraded by weed invasion and ongoing bank erosion;
- feral animals reduce the success of breeding programs for threatened birds;
- wildfires and poorly planned hazard reduction fires may degrade EECs and threatened species habitat, particularly swamp forest and floodplain wetlands; and

- there is limited connectivity between isolated areas of high habitat value, particularly in the lower estuary.

Objectives and indicators for the management of these biodiversity issues are discussed in **Section 4.5**. The significance of the risks that these issues present to estuary values is assessed in **Section 6.2**. Management responses are discussed in **Section 9**.

2.4.4 Productivity and Community Enjoyment

This major theme spans the economic, social and cultural aspects of estuary management, including land use planning, regional growth, local economic stability (primary industries, extractive industries, processing industries and tourism), foreshore and water access for safe and enjoyable recreation, the connectivity of major urban centres to the estuary, the visual character of the estuarine and floodplain landscape and both Indigenous and non Indigenous cultural heritage.

The Data Compilation Study (Umwelt 2005) identified the following issues that are aspects of natural resource productivity and community enjoyment:

- the community is concerned about the maintenance of support for community based bush care and river care programs;
- Aboriginal community values have not previously been fully incorporated into the management of floodplain and estuarine landscapes and local Aboriginal people have a low level of involvement in local natural resource management planning;
- piecemeal documentation and management of European heritage sites located on the estuary and coastal floodplain;
- congestion on boat ramps and the river upstream of Nowra, particularly during peak usage periods;
- Potential conflicts between active (high speed) and passive waterway users, particularly upstream of Nowra;
- boat generated waves are causing bank erosion in some sections of the upper estuary;
- foreshore erosion in the lower estuary affects the amenity of foreshore reserves and threatens community infrastructure;
- appropriate locations for local and regional boating facilities in the lower estuary need to be determined, to meet growing demand from the local and visitor population;
- the availability of resources for implementation of detailed planning for high usage and high profile estuary foreshore reserves e.g. associated with the Nowra CBD;
- time-frames and resources for the integration and alignment of local scale development planning with State planning strategies. Multiple related projects are in preparation;
- the provision of a secure and ecologically sustainable water supply to support urban growth around the Shoalhaven estuary, as well as extraction to augment a secure supply for the Sydney Metropolitan Area;

- the long term maintenance of commercial fisheries and oyster growing in the estuary is threatened by degradation/long term reduction of fishery habitat and high compliance costs;
- maintenance and enhancement of estuary based tourism (including recreational fishing and boating) may not be achievable, without degrading natural estuary assets and community lifestyles;
- maintenance of agricultural productivity on the floodplain whilst providing opportunities for habitat restoration – how to best manage floodplain drainage and wetland habitats in agricultural land; and
- developing adaptive farm management plans for locations where active bank erosion cannot be effectively treated/contained by structural controls (because of the nature of morphological processes or extremely high cost) and bank retreat will be allowed to continue.

Objectives and indicators for the management of these issues are discussed in **Section 5.6**. The risks that these issues present to estuary values are discussed in **Section 6.2** and management responses are discussed in **Section 10**.

2.5 MANAGEMENT ZONES

Management zones within the study area are intended to identify coherent spaces that share values, processes and management issues. Whilst the Estuary Management Plan has objectives and deliverables (natural, social, cultural and economic) for the system as a whole, its effective implementation will also benefit from the presentation of integrated action plans for localities which have specific identities.

In the brief for the Estuary Management Plan, Council suggested eight management zones as a starting point for the Plan. These were:

- Crookhaven River – from the entrance to Greenwell Point wharf;
- Crookhaven River and Creek;
- Berrys Canal – from Greenwell Point to O’Keefes Point;
- Shoalhaven River – from Shoalhaven Heads to O’Keefes Point;
- Shoalhaven River – from O’Keefes Point to Numbaa Island;
- Broughton Creek;
- Shoalhaven River – from Numbaa Island to Pig Island; and
- Shoalhaven River from Pig Island to Nowra Creek.

The justification for these zones has been carefully considered in preparing the Estuary Management Plan. The following discussion explores the relevant factors contributing to a rationale for estuary management zones.

As noted in **Section 1.1**, one of the most important characteristics of the Shoalhaven River estuary is that it is a dynamic system, with change operating at a range of spatial and

temporal scales. Key components of change include climate/sea level change, morphodynamic evolution and increasing local and regional population (permanent and visitors).

In identifying potential management zones within the estuary, the importance and interaction of each of these drivers of change has been considered.

2.5.1 Zones of Morphodynamic Integrity

The following areas are considered to be distinguishable on the basis of their morphodynamic processes and character:

- Crookhaven River and floodplain. Note the small size of the Crookhaven channel (even allowing for some long term infilling) compared with current Shoalhaven channel. The Crookhaven floodplain area should have sediments sourced from the earlier channel overlain by more recent backswamp units associated with the current Shoalhaven channel.
- Broughton Creek and floodplain. Broughton Creek has always been a tributary of the main lower Shoalhaven system. However, prior to the switch out of Crookhaven River, Broughton Creek may have joined the Crookhaven to the south of the current Shoalhaven channel (e.g. through Terara or Ryans Creek). Broughton Creek is confined to the east by Coolangatta Mountain. The footslopes of Coolangatta also limit the northern extent of the Shoalhaven floodplain. The lower Broughton Creek floodplain must contain overbank sediments derived both from the Broughton Creek catchment and from the main Shoalhaven catchment.
- Shoalhaven Heads, Crookhaven Heads, Comerong Island and Greenwell Point. This area is dominated by marine waters, marine sediments and the balance between ocean shoaling (especially at Shoalhaven Heads) and flood driven breakouts. Crookhaven Heads is tied to bedrock, and there is also a small area of bedrock terrain at Greenwell Point.
- Berrys Canal – the canal morphology is still adjusting to changing entrance dynamics and is undersized compared with the main Shoalhaven channel – particularly as most tidal flows are directed through Berrys Canal most of the time. Very high tidal velocities make the entire bed and banks unstable.
- Main Shoalhaven channel - Nowra Bridge to Bevan/Old Man Island. This is a wide and relatively straight channel, in generally unconsolidated sediments.
- Nowra Bridge to Long Point – gorge country with small pocket floodplain development.
- Long Point to Burrier – Long reach itself is bedrock controlled but floodplain areas in this section are large (and elevated?).

2.5.2 Zones of Land Use and Planning Integrity

Alternatively, management zones that are considered to have land use/planning pressure integrity could be:

- Upstream of Long Point, to Burrier – this area has relatively low recreational usage and poor access, (except to the water pumping station at Burrier). Clearing is restricted to pocket floodplain areas within the narrow bedrock confined valley. Part of the channel is directly bordered by uncleared bushland.

- Long Point to Nowra Bridge (or Bomaderry Creek junction). This reach has moderately high recreational use, and periodic very high recreational use. The sheltered waters are favoured by water ski clubs, but are also used for non powered recreational boating and fishing. There is evidence of some conflicts between these users, based around noise, safety, wave impacts on unconsolidated banks/fish habitat and general crowding of the waterway. This reach also includes the main urban settlements in the study area – Nowra and Bomaderry. Both centres are characterised by ongoing and potential growth as well as changing demand for waterfront recreational access. There are also some localised water quality issues associated with existing stormwater and waste management practices.
- Entire lower estuary and floodplain – including Broughton Creek, Crookhaven River (to Bevan Island, Old Man Island and Comerong Island). This zone incorporates the major primary production areas of the estuary and floodplain, including the fisheries of the Shoalhaven and Crookhaven rivers and the dairying/beef cattle production areas on the floodplains of the Shoalhaven River, Broughton Creek and Crookhaven River. There are occasional small villages within this zone, often of historical significance (e.g. Terara, Coolangatta). Parts of the floodplain have very high conservation value. A significant management challenge for the floodplain is the maintenance of agricultural productivity, at the same time decreasing the ecological footprint of agriculture on the floodplain.
- Shoalhaven Heads village is situated on the northern shore of the Shoalhaven entrance area and is isolated from other estuary based settlements. It is primarily a holiday centre, with pedestrian access to both the ocean beach and the estuarine shoreline. Recreational access to the estuary is available at several launching ramps and jetties, but navigable boating access from the estuary to the ocean is rare at this location.
- Greenwell Point/Orient Point/Crookhaven Heads. The southern entrance area and associated channels is a major focus of the oyster industry, commercial and recreational fishing, tourism and other estuary based recreation. The Crookhaven entrance is permanently maintained for safe navigation between the estuary and ocean.
- Comerong Island. The island lies between Berrys Canal and the ocean beach at Shoalhaven Bight. The land use focus of this area is conservation. The mangrove, saltmarsh, lagoon and littoral rainforest vegetation communities on the island have very high conservation value at a regional level and also provide habitat for migratory waders of National significance. The Comerong Island area complements the conservation values of Seven Mile Beach National Park and other wetland based nature reserves on the floodplain of the Shoalhaven River.

2.5.3 Preferred Management Zones

If both the morphodynamic factors and land use planning factors are taken into account, the following areas emerge as management zones that have broad integrity of values, processes and pressures:

Zone 1: Upper reaches of estuary – Burrier to Long Point;

Zone 2: Long Point to Bomaderry Creek junction (main recreational and urban areas, includes Nowra Creek and Flat Rock Creek);

Zone 3: Shoalhaven River - Bomaderry Creek to O'Keefes Point;

Zone 4: O'Keefes Point to Shoalhaven Heads;

Zone 5: O'Keefes Point and Berry Canal, including Comerong Island and Apple Orchard Island;

Zone 6: Greenwell Point to Crookhaven Heads (Greenwell Point, Orient Point, Curleys Bay);

Zone 7: Crookhaven River/Creek and floodplain; and

Zone 8: Broughton Creek and floodplain.

These proposed management zones are shown in **Figure 2.2**. The proposed zoning divides the coastal floodplain of the Shoalhaven system into three management units. These units highlight the separate floodplain subcatchments (Broughton Creek, Crookhaven River and Shoalhaven River) and the long term geomorphic changes that have affected the lower Shoalhaven estuary.

Three management zones across the entrance area have also been identified, differentiated on the basis of recreational and conservation values, as well as significant differences in dominant channel processes.

The upper estuary is divided into two management units. Whilst both are within the confined valley of the Shoalhaven gorge, they are distinguished by the level of urban and recreational development/activity and demands on the resources of a sensitive part of the estuary with very attenuated tidal circulation.

2.5.4 Principal Management Orientation for Management Zones

The Healthy Rivers Commission introduced the concept of a Principal Management Orientation in its work on sustainability in coastal lake systems. The concept considers the appropriate balance of values and recognises that both in natural terms and cultural terms local areas have distinctive characters which contribute to sustainability. The Principal Management Orientation provides a guide to which values would be given preference in a local area, within a sustainability framework that requires that the overall value of the system (natural, social, cultural and economic) does not decline. Although not originally designed for application to major river estuaries, the concept can be used to summarise the style of management that is considered appropriate for reaches of a large system that, whilst clearly connected, are quite distinctive.

The four classes of management orientation identified by the Healthy Rivers Commission (2002) were:

- Comprehensive Protection (i.e. focus on significant protection measures to maintain near pristine conditions);
- Significant Protection (partly modified systems, which have largely natural catchments, and some significant conservation values within a land use pattern that offers opportunities for enhanced natural values);
- Healthy Modified Condition (moderately developed sections of the system (waterway and catchment), often with relatively robust values that can sustain ongoing carefully selected and managed development); and
- Targeted repair (heavily developed sections where maintenance of development values is considered very important and where there are only limited opportunities to restore natural values).

Table 2.2 suggests Principal Management Orientation for each of the eight management zones of the Shoalhaven River estuary. This value preference is taken up further in **Section 6** (acceptability of risks to values) and **Section 11**, which draws together the proposed management actions for each zone of the estuary.

Table 2.2: Principal Management Orientation

Management Zone	Principal Management Orientation (value preference)
Zone 1 (Burrier to Long Point)	Comprehensive Protection to Significant Protection
Zone 2 (Long Point to Bomaderry Creek)	Significant Protection to Healthy Modified
Zone 3 (Shoalhaven River, Bomaderry Creek to O'Keefes Point)	Healthy modified
Zone 4 (O'Keefes Point to Shoalhaven Heads)	Significant Protection
Zone 5 (Berry Canal, including Comerong Island and Apple Orchard Island)	Significant protection
Zone 6 (Greenwell Point to Crookhaven Heads)	Significant Protection
Zone 7 (Crookhaven River/Creek and floodplain)	Significant Protection
Zone 8 (Broughton Creek and floodplain)	Healthy modified to significant protection

3.0 OVERARCHING PRINCIPLES AND GUIDELINES

The Estuary Management Plan will assist Shoalhaven City Council to demonstrate implementation of the principles of Ecologically Sustainable Development (ESD) as they pertain to the natural resources of the Shoalhaven River estuary.

These ESD principles, which are also the principles underlying the NSW Coastal Policy, include:

- intergenerational equity (what values and risks or costs are we handing on to future generations?);
- biodiversity and ecological integrity (maintain ecological processes and the structure of ecological communities);
- maintain natural capital (natural resources have intrinsic value that can be used to assess risks, costs and benefits);
- protect social integrity and social equity (sustainable regions have actively engaged communities with fair access to resources and benefits);
- economic viability (regional economies should be based on investment in activities that appreciate the natural resource constraints and opportunities, so that they are built into business planning);
- precautionary principle (action to protect threatened, highly valued resources should not be delayed while we search for certainty about processes and impacts);
- assessment of risk weighted consequences – improved valuation and pricing, plus incentive mechanisms, taking all aspects of natural resource value into account; and
- avoid irreversible damage to the environment (i.e. change that is outside the range of natural variability and may shift the system into a different state).

3.1 COUNCIL'S STRATEGIC POSITION

The Estuary Management Plan is one of several strategic planning documents that guide Council's approach to sustainable natural resource management. Because of its focus on system wide sustainability, the Estuary Management Plan considers social, cultural and economic issues and objectives as well as environmental ones.

Council's overall Vision statement highlights the integration required of estuary management objectives as well as foreshadowing important outcomes from estuary management.

Shoalhaven City Council Vision

We will work together in the Shoalhaven to foster a safe, attractive place for people to live, work, stay and play; where growth, development and environmental protection are managed to provide a unique and relaxed lifestyle.

SCC has prepared Guidelines (2003) which provide a framework for how Council will integrate ESD into both its strategic planning and all aspects of its day to day activities. Consideration of ESD principles is required under *Local Government Act 1994*.

ESD is an aim of the Shoalhaven City LEP:

“to work towards an ecologically sustainable future through the proper management, development, protection, restoration, enhancement and conservation of the environment of the City”.

Several aspects of Council’s ESD Guidelines are directly relevant to the scope and direction of the Estuary Management Plan, including “Task Guidelines” for all sections of Council.

Section 5 identifies estuary management and estuary health outcomes that are considered to be consistent with Council’s obligation to manage the City’s resources in an ecologically sustainable manner.

3.2 TARGETS AND BENCHMARKING

The NSW Natural Resources Commission has provided some generic resource condition targets for all NSW estuaries. These are noted below and have been taken into account in the Catchment Action Plan (see **Section 3.3**) and in developing objectives and satisfactory outcomes for the Shoalhaven River estuary.

3.2.1 NRC Resource Condition Targets

The following targets were recommended by the Natural Resources Commission in relation to estuary condition:

- by 2015, there is no net loss of native seagrass, saltmarsh and mangrove;
- by 2015, there is a net improvement in the condition of estuaries, as assessed against the Ecosystem Integrity Index (EII) established in the National Land and Water Resources Audit (NLWRA); and
- by 2015, there is a net reduction in productive capacity (agriculture) lost due to salinity, acidity, erosion, acid sulfate soils and invasive species.

3.2.1.1 The Ecosystem Integrity Index

The EII, as developed by CSIRO, has the potential to consider the following types of data, and is supplemented by a habitat condition index, water quality index, fish condition index and water quality index. The EII assesses a range of factors, including:

- eutrophication;
- chlorophyll a at the mouth, middle and upper reaches of the estuary;
- harmful algal blooms;
- turbidity (mouth, middle and upper reaches of the estuary);
- shellfish closures;
- fish/bird kills;
- pathogens;

- faecal coliforms (mouth, middle and upper reaches);
- critical habitat loss;
- anoxic and hypoxic events; and
- invasive species.

Insufficient data currently exists to provide a full assessment of the Index. Suggestions for practical EII parameters for the Shoalhaven River Estuary are provided in **Section 7.1.1**.

3.3 CATCHMENT ACTION PLAN AND INVESTMENT STRATEGY

The Southern Rivers Catchment Management Authority has prepared a single Catchment Action Plan and Investment Strategy (2005) for the whole of the Authority area. The document is currently in final draft form, awaiting endorsement by the Minister for Natural Resources. Once endorsed, the CAP will be current for ten years (2006-2016). In this document, the overarching target for coastal and marine parts of the catchment area refers to an improvement in the condition of coastal and estuarine environments above current levels (as measured by the EII). Importantly, the overall target also refers to this improvement being achieved by a partnership between state and local government, industry and residents. The preparation and implementation of this Estuary Management Plan is an example of such a partnership.

The Catchment Action Plan includes five Management Targets for coastal and estuarine landscapes. Target 1 refers specifically to the open coastline, but Targets 2 to 5 relate (at least in part) to estuarine landscapes. These targets are noted below, and the Estuary Management Plan contains actions that give effect to the targets (see **Sections 8 to 11**).

The CAP also includes a range of targets for community and partnerships, biodiversity, soil and land capability and water management that are relevant to the Estuary Management Plan. These are noted in **Section 3.3.1**.

Note that the time frame for all the CAP coast and estuary targets is around ten years, with limited guidance on intermediate achievements and outcomes.

Target 2: Protecting and Rehabilitating Estuaries

By 2016, maintain or improve the condition of estuaries through development and implementation of natural resource management plans (including estuary management plans).

The CAP is not specific about the types of actions or appropriate performance indicators relating to this target, although clearly the preparation and adoption of an Estuary Management Plan for the Shoalhaven is a step towards improved estuary health. The CAP also refers to the value of including both Aboriginal community representatives and estuary users (oyster farmers, commercial and recreational fishers) in management actions and in the preparation of subsidiary or sectoral plans (such as Fishery Management Strategies) to support the overall direction of estuary management (see also Target 3).

The CAP lists a variety of indicative “projects” that would illustrate the activities outlined. These indicative projects are noted below (**Table 3.1**), together with a reference to how the Estuary Management Plan has further developed the concept into specific recommendations for programs of actions.

Table 3.1 - Projects nominated by the CAP

CAP Indicative Project Concepts for improved estuary health	Section of Estuary Management Plan providing more information
Support estuary users (oyster growers and others) in attempts to remediate water quality.	Maintaining suitable water quality for oyster production (to meet specified health standards for uncooked seafood) is a major challenge for oyster growers, and all oyster growers are part of the industry Quality Assurance Program. DPI is working on a whole of coast strategy for ensuring suitable estuarine waters for oyster production (see Section 4.8). The current implementation of the QAP in the Shoalhaven estuary is discussed in Section 4.8 , together with information about issues that remain to be addressed, to minimise risks to sustainable oyster production. Actions to support a sustainable oyster industry in the Shoalhaven River estuary are discussed in Section 10.4 .
Protect and improve aquatic habitat for fish – seagrass, saltmarsh and mangroves (see NRC targets in Section 3.3.1).	Umwelt 2005 describes the current status of these communities in the Shoalhaven and the threats to meeting the NRC objective, particularly for saltmarsh. Proposed measures to retain the balance of saltmarsh and mangrove habitat, as well as to protect seagrass beds are discussed in Sections 9.3, 9.4 and 9.5 . Other aspects of riparian vegetation restoration, which complement aquatic habitat protection measures, are discussed in Section 9.2 .
Remove barriers to fish passage (design and location of weirs, road crossings and flood gates).	DPI has been implementing a program for removal of priority barriers to fish passage in NSW estuaries for several years (Bring Back the Fish program). In the Shoalhaven estuary, the management of fish passage is linked particularly to the management of acid sulfate soils and flood gates. Proposed enhancement actions are discussed in Section 9.1 .
Reduce excessive sediment and nutrient load entering estuaries, including working with catchment land users to control nutrient exports.	Sediment loads in the Shoalhaven River estuary are contributed from catchment runoff, from bank erosion along the estuary (generally alluvial floodplain sediments) and from incursion of marine sediments in the lower estuary. Sections 8.3 and 8.4 address bank erosion controls and other measures. Local nutrient and organic loads also increase when floodplain banks are eroded. Nutrient loads are also affected by stormwater runoff from urban areas and from floodplain land uses (such as dairying). All of these sources are generally well known and a variety of programs are in place. These are discussed in Sections 4.3, 8.3 and 8.4 , together with suggestions for improved targeting or enhancement of actions.
Reduce impacts on estuaries from industrial discharges.	Industrial land uses in the Shoalhaven are limited to the Bomaderry industrial area. Licensing and development consent controls are in place on major industries in this area (see Section 4.1.1 and Umwelt 2005).

Table 3.1 - Projects nominated by the CAP (cont.)

CAP Indicative Project Concepts for improved estuary health	Section of Estuary Management Plan providing more information
Manage freshwater flows into the estuary.	The updated Estuary Data Compilation Study (Umwelt (2005)) discusses the current situation in terms of water extraction and fresh water flow management.
Manage tidal flows into the estuary (dredging and entrance management policies).	The Estuary Management Plan supports maintenance of a permanent navigable channel, protected by seawalls at Crookhaven Heads. The Plan highlights the interaction between this entrance, the ongoing adjustments to Berrys Canal and the intermittent nature of the Shoalhaven Heads entrance. The Entrance Management Policy for Shoalhaven Heads (see Section 8.2.1) focuses on minimum intervention, except when properties are threatened by flooding and there is a companion policy about floor levels and property acquisition in flood prone areas. Council is reviewing the triggers in the entrance management policy in the light of new information about potential flooding in the Shoalhaven Heads village.
Manage Acid Sulfate Soils.	The acid sulfate soils in the Broughton Creek catchment have been extensively studied and were recognised as an ASS 'hot spot' in the (then) DLWC strategy in the 1990s. Ongoing actions in this area are discussed in Section 4.1.1 . On the Crookhaven floodplain, recent studies have been conducted to review the significance of any ASS threats (see SCC 2006).
Manage riparian vegetation (including riparian vegetation incentives program).	The Shoalhaven estuary study area (estuary and floodplain) contains examples of 12 EECs. Almost all of these are threatened by either bank erosion (e.g. at Comerong Island) or by various aspects of floodplain management. In addition, existing efforts to control bank erosion and restore riparian habitat have focused on mangrove, reed bed and swamp oak replanting (see Section 4.1). Proposed future actions to restore riparian habitats and protect critical remnant habitats are described in Sections 9.2 and 9.3 .
Ongoing estuary health indicator monitoring program (selection of appropriate indicators and testing).	This project is critical to meeting the primary targets for estuary health – without an agreed, practical suite of indicators and a relevant data collection program, it will not be possible to evaluate trends in estuary health. Progress towards a meaningful indicator and monitoring program and proposals for the estuary are discussed in Section 7.1.1 .
Implement Estuary and Coastal Lakes Incentives Program.	Shoalhaven City Council has received grants totalling \$150,000 from the Incentive Program for estuary management actions in 2006 – for bank protection works at Greenwell Point and Nowra Rowing Club (see Section 10.3). Council has also received funds from the Environmental Trust for remediation of the old Nowra Gasworks site, which is approximately 500 metres from the bank of the estuary.

Target 3: Sustainable Management of Aquatic/Marine Resources

By 2016, Best Management Practices have been developed and adopted by key aquatic/marine industries, providing for the sustainable use of aquatic/marine resources.

The performance indicators identified in the CAP are principally directed at improving the awareness and engagement in good practices of commercial, recreational and Indigenous fishers. Whilst much of this activity is managed by DPI through industry based fishery management advisory committees, the CMA has expressed an interest in providing an additional natural resource management perspective. Of particular note, apart from general industry engagement, is the reference to preparation of an Indigenous aquaculture strategy in the Southern Rivers CMA area.

Target 4: Protecting Aquatic/Marine Biodiversity

By 2016, active management arrangements are implemented in order to protect or improve all key aquatic habitat areas (including listed threatened/endangered species and ecological communities), in partnership with relevant authorities and user groups.

There are 12 EECs identified in the Shoalhaven estuary and floodplain. However, the focus of this program through the CMA appears to be more on open coastal environments than on estuaries. Notwithstanding this focus, the Estuary Management Plan contains several significant actions for the protection of important estuarine habitats.

Target 5: Conducting Strategic Coastal and Marine Research

By 2007, a research strategy will be developed to improve scientific knowledge and understanding of coastal, estuarine and marine environments and processes, to be progressively implemented by 2016s.

The Shoalhaven River Estuary Data Compilation Study (Umwelt 2005) noted both the extent of previous studies of estuary processes and estuary status, and the low level of information currently available about some important issues. The Estuary Management Plan highlights the importance of monitoring and research projects to help improve certainty about likely changes associated with climate change and sea level rise, as well as better understanding the sensitivity of estuary morphodynamic processes.

Further audit style studies of aquatic and wetland habitats are also recommended so that long term changes can be gauged.

3.3.1 Other CAP targets relevant to estuary management

In addition to specific targets for coast and estuary management, the CAP identifies the following targets for aspects of catchment management that have relevance for the management of the estuary. These targets have been taken into account in preparing and evaluating the management actions presented in **Sections 8 to 11** of the Estuary Management Plan.

Community and Partnerships Catchment Targets

- C4 - By 2016 there will be an increase in community awareness, knowledge and skills in relation to natural resource management and an increase in the adoption of practices that improve natural resource outcomes.

- C5 – By 2016 an effective mix of incentives, regulation, education and community support programs will be in place to achieve the biophysical targets of the Catchment Action Plan.

Biodiversity Catchment Targets

- B4 - By 2016 the priority recovery actions identified in the Southern Rivers Threatened Species strategy will have been implemented.

Soil and Land Capability Catchment Targets

- SLC4 – By 2016 manage according to best practice:
 - all exposed acid sulfate soils; and
 - all land identified as having an active acid sulfate soil risk within its capability.

Water Management Catchment Targets

- W2 – By 2016 the quality of priority water bodies will be maintained or progressively improved.
- W5(a) – By 2016 an additional 2,000ha of riparian vegetation will be actively managed for improved ecosystem condition.
- W5(d) – By 2016 priority actions and works will be implemented to protect and enhance 40 wetlands of national and regional importance identified as priorities.
- W5(e) – By 2011, local environment plans (LEPs) will incorporate minimum vegetated buffer distances to protect waterways from impacts of development.

3.3.2 SRCMA Estuary Benchmarking Project

The Catchment Action Plan and Natural Resource Commission both refer to evaluating the performance of estuary management activities by referring to improved estuary condition in terms of the parameters used in the National Land and Water Resources Audit. The Shoalhaven River estuary was included in the NLWR Audit, and its condition was considered to be poor. The NLWRA used the concept of an Ecosystem Integrity Index to provide an integrated measure of estuary health or condition. However, the audit assessment had access to very limited information about the Shoalhaven River estuary. There was no information to assess many of the parameters included in the Audit process.

More recently, the CRC for Coastal Zone, Estuary and Waterway Management (CRC 2004) has prepared a detailed report on appropriate indicators of estuary and coastal health for use in natural resource management monitoring programs. The CRC presents indicators for two aspects of estuarine habitat integrity:

- estuarine habitat condition (drawing on the presence of various stressors of estuarine habitats); and
- estuarine habitat extent and distribution.

Stressors include a variety of processes and process drivers, including hydrodynamics, freshwater flow regime, habitat removal or disturbance, presence of toxicants, pathogens etc. A range of indicators is considered in relation to each of these stressors.

Based on the guidance provided in the CRC report, the following indicators could be considered for ongoing monitoring of the health of the Shoalhaven river estuary.

Morphodynamic stressors and indicators:

- estuary mouth opening and closing;
- pH;
- salinity; and
- sedimentation and erosion rates.

Biological stressors and indicators:

- Chlorophyll-a;
- targeted pathogen monitoring (only near oyster leases or swimming areas); and
- algae.

Habitat extent:

- extent/distribution of key habitat types (seagrass, saltmarsh, specific EECs, reedbeds); and
- seagrass depth range.

The NSW Natural Resources Commission and the SRCMA recognise the importance of having a clear benchmark of estuary condition against which future changes can be assessed. The SRCMA also recognises the problems (meaningful data sets and resources) associated with direct application of the full suite of EII parameters.

The SRCMA is commencing a new estuary benchmarking project which will identify suitable variables to be regularly monitored in the estuaries within its boundaries. The project will provide a benchmark for each estuary using the selected variables. The project will continue for approximately twelve months and will be supervised by an expert scientific panel.

Variables which are likely to be included are:

- turbidity;
- chlorophyll-a;
- faecal coliforms;
- critical habitat loss;
- invasive species; and
- ecosystem events, such as shell fish closures, fish/bird kills, anoxic and hypoxic events, algal blooms, oil spills etc.

This suite of potential indicators of estuary health implements the key morphodynamic, biological habitat stressors and indicators noted by the CRC.

As noted in **Section 7.1.1**, the results of the benchmarking project and ongoing monitoring against the selected benchmark indicators will be a key tool for future assessment of the success of natural resource management measures in the Shoalhaven River estuary.

PART 2: COMPONENTS OF SUSTAINABLE ESTUARY MANAGEMENT

This part of the Estuary Management Plan reviews the values of the Shoalhaven River estuary and its associated floodplain and considers the significance of threats to those values. The significance of threats is discussed firstly in qualitative terms (**Section 4**) and then refined using a simple risk assessment process (see **Sections 6** and **Appendix 1**). **Section 5** sets out the objectives for managing the estuary.

4.0 VALUES OF THE SHOALHAVEN RIVER ESTUARY

As noted in **Section 2**, values in natural resource management context are statements about the ways in which the landscape context of people's lives is important, and about how they intend to contribute to decisions about the management of that landscape context.

This section explores and details the full range of values of the Shoalhaven River estuary, identified by Council, State and Commonwealth agencies, local residents and businesses and visitors to the region. It includes previous statements about the values of the Shoalhaven community in relation to the value of the estuary, as well as contributions made by community members during the preparation of the Estuary Management Plan.

As noted in **Section 2**, there is potential for extensive overlap of values between the various stakeholders, but also potential for widely divergent views on some values. By understanding the range and intensity of values, management strategies that provide the best net value outcome for the natural system and for the community can be negotiated.

Shoalhaven City Council has adopted the following value statements to guide its operations (**Table 4.1**). Each of these values is relevant to the management of the Shoalhaven River estuary and is consistent with views expressed by individuals from the Shoalhaven community during the current project.

Table 4.1 - Shoalhaven City Council Value Statements

Common values with the wider community	Additional values upheld by Councillors and staff
<ul style="list-style-type: none"> • Preserving and enhancing our lifestyle. • Protecting the beauty of the Shoalhaven. • Encouraging a sense of community in our villages and towns. • Equal access to services for all people. • Recognising the needs of all groups. • Creating opportunities for employment. 	<ul style="list-style-type: none"> • Council's role as custodian for present and future generations. • Honesty, impartiality and consistency in decision making. • Efficiency and effectiveness. • Provision of quality innovative services. • Working with the community. • Being a responsible employer.

Sections 4.1 to 4.10 elaborate on the biodiversity, social, cultural, economic and scientific values of the Shoalhaven River estuary. Each of these sections also provides information about current or likely future threats to the values of the study area.

4.1 ECOLOGICAL AND BIODIVERSITY VALUES

Residents and visitors value the “clean” water of the Shoalhaven River estuary, which supports healthy estuarine ecology, primary production and water based recreation. Whilst there are occasional non compliances with ecological and public health guidelines for water quality (see **Section 4.8.1** for details about water quality management issues associated with the oyster industry in the lower estuary, and **Sections 4.1.1** and **4.8.1** in relation to acid sulfate impacts), the overall community image of the estuary is one of variable but good water quality.

Examples of variability and their ecological influences are reported by anglers in the upper estuary. During periods of low flow, such as occurred in the period 2001 to 2004, the salinity of the upper estuary increases under persistent tidal influence. Fisherman report an influx of jelly fish in the upper estuary at this time, together with increased algae in the estuary and a change in the distribution of fin fish targeted by recreational fishers

The estuarine wetlands of the Shoalhaven River estuary are amongst the most extensive on the NSW south coast. Mapping by DPI and NLWR audit indicate that the estuary contains approximately 1 km² of seagrass (primarily *Zostera*) (4.9% of the estuary area), 3.5 km² of mangrove (17% of estuary area) and 1.5 km² of saltmarsh (7.4% of estuary area). The distribution of aquatic communities, as mapped by DPI in 2004, is shown in **Figure 4.1**. The largest area of littoral rainforest on the south coast is located on Comerong Island.

Extensive areas in the lower estuary, including Comerong Island, Bevan/Old Man Island and the margins of Curleys Bay have been mapped as SEEP 14 wetlands. Both the estuarine wetlands of the Shoalhaven/Crookhaven Estuary and Coomonderry Swamp (freshwater wetland) are listed in the Directory of Important Wetlands in Australia.

Coomonderry Swamp is the largest freshwater wetland on the south coast and is in good condition. It provides drought refuge and habitat for sensitive species. Although the area of other freshwater wetlands on the Shoalhaven floodplain has been greatly reduced, the floodplain and estuarine wetlands of the lower Shoalhaven still contain large areas of Endangered Ecological Communities (EECs), with eight EECs represented across this part of the study area. The distribution of EECs is shown in **Figures 4.2a** and **4.2b**.

Parts of the Shoalhaven River estuary have particular value as habitat for migratory wading birds. The sand shoals inside Shoalhaven Heads and the wetlands on Comerong Island are important habitat areas for some 90 species of shore birds and waders, including 27 species that are subject to international agreements. The lower estuary is of international significance for the Pacific Golden Plover and the Double Banded Plover (the Comerong Island Nature Reserve has half the known NSW population of this species), Eastern Curlew and Whimbrel. Other species of State and National Significance include the Pied Oystercatcher, Sooty Oystercatcher, Ruddy Turnstone, Bar Tailed Godwit, Greenshank and Red Necked Stint (DEC 1998). The Little Tern, Red Capped Plover and Pied Oystercatcher are known to breed on the Shoalhaven sandpit.

DEC (2005) identifies the Shoalhaven local government area as a “stronghold” for the green and golden bell frog in NSW. Significant populations are known to occur in Coomonderry Swamp (partly within Seven Mile Beach National Park), and in wetlands on the Crookhaven floodplain (Greenwell Point, Brundee Swamp, Saltwater Swamp and parts of Currumbene State Forest). The Crookhaven floodplain populations are on land partly managed by DECC (e.g. Brundee and Saltwater Swamp Nature Reserves), partly managed by Council, private land and land managed by DPI (State Forest). DECC has prepared a draft Species Recovery Plan for the Green and Golden Bell Frog (2005) which identifies several strategies that are relevant to the Shoalhaven populations. These include establishing local “Friends of the Green and Golden Bell Frog” groups, monitoring of populations on land managed by DECC,

and preparation of specific local management plans for the frog on DECC managed lands. DECC also proposes to work with adjacent landholders to enhance habitat continuity across land tenure wherever possible. DECC has released a draft Plan of Management for Brundee Swamp and Saltwater Swamp (January 2006) which includes actions to maintain or improve the hydrology of floodplain wetland habitats that are suitable for the Green and Golden Bell Frog.

4.1.1 Threats to Biodiversity Values

Biodiversity threats and their distribution in the Shoalhaven River estuary are summarised in **Table 4.2**. The distribution of threats is also shown in **Figure 4.1** (aquatic habitats) and **Figures 4.2a** and **4.2b** (floodplain habitats and EECs).

Table 4.2 - Threats to Biodiversity Values in the Shoalhaven River Estuary

Threat type	Examples and distribution, commentary
Removal or reduction of numbers of individual species, through habitat destruction/modification, or over-harvesting.	There is little or no data on the populations of individual threatened species in the Shoalhaven estuary area, nor on the relationship between trends in populations in the Shoalhaven and other south coast waterways. It is clear however, that changes in specific habitats (such as shallow shoals, or increased access by predators) may contribute to loss of individual species numbers. As an example, roosting and breeding habitat for migratory waders in the lower estuary is particularly vulnerable to changes in sea level and to changes in erosion and shoaling patterns.
Removal or reduction in the area of individual EECs, most commonly through clearing for agricultural or urban development purposes, but also because of ongoing severe bank erosion and channel change.	Perhaps the most important threat to biodiversity in the Shoalhaven estuary to date has been the clearing of riparian and floodplain vegetation from the banks of the Shoalhaven River, Crookhaven River and Broughton Creek, compounded by floodplain drainage and flood mitigation schemes that have changed the hydrology of floodplain wetlands and increased the acidity of surface and ground water. Saintilan and Rogers (2000) report dramatic changes to the area of floodplain wetland habitat over a 20 year period. Although some wetlands had increased in area, many had decreased (e.g. Broughton Creek wetland decreased in area by 20% and Greenwell Point wetland by 50%).
Changes in the balance between different habitat types (e.g. saltmarsh and mangrove), potentially associated with changes to sediment load or with sea level rise.	The capacity of saltmarsh habitat to adjust to sea level rise depends on the control of other threats, and on the presence of local morphology which allows the retreat of extensive intertidal areas. This terrain has limited distribution in the lower Shoalhaven, although new shoaling patterns may add some intertidal spaces.
Persistent changes to tidal incursion and salinity, associated with entrance management or with sea level rise.	It is likely that the training walls and opening of Berrys Canal have already affected the salinity profile of the estuary, adding to the effects of low flows in drought. Persistent changes in salinity of the upper estuary, with more effective tidal incursion, may marinise the species distribution, at the expense of species with only brackish salinity tolerance, or may allow more marine species to penetrate further into the upper estuary.

Table 4.2 - Threats to Biodiversity Values in the Shoalhaven River Estuary (cont.)

Threat type	Examples and distribution, commentary
Persistent changes to fresh water inflows to the estuary, either through prolonged drought/climate change or excessive or inappropriately timed water extraction.	All of these processes result in increased (greater length of channel) or more persistent salinity (more saline events or longer saline events) of the upper estuary, or reduce the freshwater flushing of the upper estuary. The results would be similar to increased tidal efficiency. It is also possible for changes to certain freshwater flows to impact on freshwater inundation of floodplain habitats. For instance, disruption of relatively frequent moderate freshes (1 in 5 year events) to floodplain wetlands would impact on the viability of species and communities.
Removal or degradation of microhabitat features for fish (such as deep pools or shading)	Changes to sedimentary patterns in the estuary may result in both the removal and the creation of deep pools against high banks, depending on the relationship between the main channel alignment and the bank. If deep pools are infilled, habitat diversity is reduced. Other factors in the upper estuary include lack of snags or other organic debris along the banks in agricultural areas because of the lack of riparian vegetation.
Continuing presence of barriers to fish passage – primarily physical, but acid water is sometimes referred to as a chemical barrier to fish passage. Discharges of low pH waters from actual ASS.	Barriers to fish passage include flood gates, roads and culverts. DPI has prepared a list of priority sites on the south coast where barriers should be removed, consistent with the ASS management objectives noted in “Restoring the Balance (DPI 2003) (see Section 4.1.1.1). Physical barriers may prevent fish accessing sheltered parts of estuarine channels, or floodplain wetland habitats. They also prevent fish from moving above the tidal limit. Both issues affect breeding success.
Industrial and stormwater discharges.	Some data from the Shoalhaven estuary (now ten years old) suggested that discharges from processing industries along the estuary affected water quality, sediments and biota near the discharge points. There was also some evidence of heavy metal pollution in specific parts of the estuary. Stormwater pollutants include bacteria from on site wastewater treatment plants. This is more a human health issue than a biodiversity issue.
Potential spread of noxious marine algae (<i>Caluapa taxifolia</i>) from existing infestations in St Georges Basin to the Shoalhaven.	<i>Caluapa taxifolia</i> is an aggressive invader of aquatic habitat and has the potential to smother other habitat. It is present in several local estuaries/lakes and could be transferred from these systems to the Shoalhaven by recreational vessels.

4.1.1.1 Threats from poor understanding of floodplain drain management issues

DPI (2003) describes common threats associated with floodgated drains on coastal floodplains in Australia. Most of these twelve impacts and a range of associated management issues are relevant to the Shoalhaven coastal floodplain. The impacts noted are:

- impacts on juvenile fish and prawn migration (passage is blocked by closed floodgates – priority sites for the Shoalhaven are documented by DPI and listed in **Table 8.1**);
- reduced fish passage and recruitment of juvenile fish behind floodgates;

- increased incidence of “red spot” disease in fish and other sub lethal effects on fish and oysters;
- fragmentation and loss of fish habitat (physical and chemical separation);
- increased fish kills from acid or deoxygenation (from decay of backswamp or drain vegetation, algal blooms, etc.);
- increased export of acid and/or toxic metals from acid sulfate soils. In the Shoalhaven system, this impacts appears to be primarily associated with Broughton Creek);
- enhanced “black water” impacts – rapid transport of deoxygenated water from the backswamp areas to the estuary;
- increased acid discharge as a result of drain pumping in high permeability acid sulfate soils;
- nutrient accumulation in drains and backswamp areas, enhancing the risk of algal blooms;
- increased monosulfidic ooze (MBO) formation in drains, with subsequent transport to the estuary. This affects estuary water quality and fish habitat;
- wetland loss and reduced habitat for water birds and waders;
- more fires in backswamps, leading to loss of organic topsoil (peat) and surface scalding; and
- risk of saline tidal overtopping of drains if floodgates are opened too often, or for too long or at the wrong time. The intent of floodgate management, integrated with ASS management is to reduce the blockage, habitat and water quality impacts of floodgates and drains, but at the same time, maintain viable and productive floodplain agriculture. A high risk of drain overtopping would threaten floodplain agriculture (low tolerance of saline surface water). Similarly, if floodgate opening would allow saline/brackish water into fresh water floodplain wetlands, there would be a net loss in quality habitat. So drains need to be very carefully managed.

4.1.2 Catchment flows

Flows from the Shoalhaven River catchment into the estuary are highly variable, ranging from less than 100ML/day to about 60,000ML/day. This variability has a major influence on estuary water quality (e.g. salinity) and morphology, and hence on aquatic and riparian ecology. Flow management (water extraction primarily by SCA and Shoalhaven Water) is superimposed on this natural variability.

Community concerns about potential impacts of flow management on the estuary include:

- salinisation of the upper estuary (with associated ecological influences);
- reduced productivity of the oyster industry in the lower estuary;
- the frequency, duration and extent of floodplain wetland inundation; and
- changes to erosion/sedimentation regimes in the upper estuary.

There are also concerns about the interaction of flow management, flooding and the entrance management policy for Shoalhaven Heads (which links artificial entrance opening to risks associated with flood levels). Several of these aspects of potential impact affect Council responsibilities (particularly in relation to flood levels and entrance management).

SCA is currently considering options for management of environmental flows and water extraction in the Shoalhaven River.

SCA (2006) notes that the current Shoalhaven scheme transfers water from Tallowa Dam into the Metropolitan water supply during drought conditions. The transfers coincide with low flows in the Shoalhaven River. Whilst the current scheme can increase stress on the river at low flow, it has little impact on moderate to high flows, and Tallowa Dam has spilled on ten occasions since April 2003.

HRC (1999) noted that the presence of Tallowa and Danjera Dams and the Burrier Weir Pool in the catchment, under the environmental flow provisions operating at that time, had minimal impact on low flows, minimal impact on very high flows (which pass through the dams unmodified), but would have some impact on low-medium flows. Norman and Turner (1999) noted that flushing of the estuary is dependent on the frequency of flood events (known to be highly variable), rather than the operation of the dams.

HRC (1999) concluded that flow modification by water supply authorities had not led to high flow stress. Other impacts of the dams (such as fish barriers and water quality issues) were considered to be more significant. It is a requirement of the operation of the Burrier Weir that sufficient flow is maintained over the rock control to allow the passage of bass.

SCA is currently working towards a modified flow management regime for the Shoalhaven Scheme, with a view to achieving higher yields for water supply. An objective of this project is to modify the current flow rules to minimise the impacts of extraction on the estuary by creating a flow regime that mimics natural flow variability better than does the current operating regime.

SCA and DWE are currently undertaking a range of studies to better define the potential impacts on the Shoalhaven River downstream of Tallowa Dam and on the estuary. The (then) Department of Natural Resources (Boyes (May and August 2006)) provided a review of current knowledge of environmental flow issues and relationships for the Shoalhaven River and estuary. Matters considered include fluvial and estuarine geomorphology, sediment transport, acid sulphate soils, impacts of dam stratification on downstream water quality, stratification of natural pools, estuary salinity, fish ecology, aquatic macroinvertebrate ecology, wetlands and water birds and riparian ecology. Each of these issues has been considered in relation to the NSW environmental flow objectives. Critical environmental flow objectives for the Shoalhaven River downstream of Tallowa Dam are considered to be:

- protect natural low flows;
- protect or restore a proportion of freshes and high flows;
- maintain and mimic natural flow variability;
- ensure that management of river flows provides the necessary means to address contingent environmental and water quality events; and
- maintain and rehabilitate estuarine processes and habitats (noting that the other objectives also contribute to this objective).

At this stage, the available evidence suggests that ecological and geomorphic variations observed in the estuary as a whole are overwhelmingly due to rainfall induced flow variability and to tidal flows, rather than water extraction. In addition, the estuary continues to adapt to significant structural intervention at Berrys Canal and Crookhaven Heads. This affects both the velocity and penetration of tidal flows and bank erosion dynamics in the lower estuary (see **Section 4.3.1.2**).

Consistent with earlier studies that suggested that the upper estuary would be most vulnerable to any water quality or ecological impacts of changed extraction rules, detailed modelling and additional ecological assessments have focused on the estuary upstream of Nowra. SCA (2006) notes that the method used in these studies is consistent with the National Environmental Flows Initiative, particularly the estuarine processes studies (Peirson 2002).

The results of recent and current studies of the upper estuary will be considered in the Government's final recommendations for the management of environmental flows in the Shoalhaven River and estuary.

On the basis of the information that is currently available and the scope of potential flow related issues in the estuary, the short term focus of management of catchment flow issues in the estuary should be on communication and information sharing. This will help to alleviate community concerns and ensure that those responsible for estuary management have access to the most recent and high quality modelling and field data. The SCA community briefing and consultation program which will be conducted in late 2006 will assist this process.

Clearly, if significant changes to estuary condition are subsequently observed, the potential contribution of flow management will need to be reviewed (adaptive management procedures).

4.2 LANDSCAPE DIVERSITY – THE BEAUTY OF THE SHOALHAVEN

The landscape of the Shoalhaven River estuary can be broadly divided into three sections:

- the upper estuary, where the river channel is closely confined within steep, vegetated slopes and high sandstone cliffs, with non continuous “pocket” floodplain areas;
- the lower estuary (downstream of Nowra) where the wide estuary channel is set within an extensive floodplain, now largely cleared and used for agriculture. On the northern side, diversity is added to this landscape by the presence of Cooloongatta mountain; and
- the estuary entrance area, comprising (at Shoalhaven Heads), wide sandy beach and shoals, with extensive estuarine wetlands (mangrove and saltmarsh), and at Crookhaven Heads, the landmark headland. The waters of this part of the estuary landscape are more marine than elsewhere.

The visual quality of the landscape formed by the Shoalhaven River estuary and its coastal floodplain is highly regarded by local residents and visitors. It has also been recognised in both National Heritage listings (Coomonderry Swamp Nature Reserve) and in the NSW National Trust Register.

Bundanon homestead in the upper reaches of the estuary is also listed in the Register of the National Estate and has an indicative listing in the Commonwealth Heritage List. The listing refers to a “unique landscape of great natural beauty.”

The NSW National Trust has classified the Berry Landscape Conservation Area. This area includes the coastal landscape south from Kiama to Greenwell Point. The lower Shoalhaven River estuary and associated coastal floodplain are key elements of this valued rural landscape.

A number of other studies have also identified the scenic quality of the Shoalhaven River estuary. For instance, the Master Plan for The Grotto/Greys Beach area recognises the importance of the reserves for sight seeing. Lookouts in The Grotto Reserve provide outstanding vistas of the upper reaches of the estuary (see **Plate 4.1**).

Council's Foreshore Reserves Policy recognises the importance of water views to many residents. It includes a clause that requires that revegetation programs in foreshore reserves respect the views of existing residents, by planting with a mix of tall and low growing plants that protect scenic outlook for residents.

Overall, the key qualities of the landscape of the Shoalhaven that are valued by the community include:

- Diversity – the gorge country of the upper Shoalhaven River estuary is dramatically different landscape to the wide waterway, low or gently undulating relief and open estuarine floodplain in the lower estuary.
- Natural or rural outlooks. The Berry Landscape Conservation area comprises a mix of natural areas (often in National Park management), historic villages and rural lands (dairying and horticulture). The upper estuary is enclosed in a high sandstone gorge, with natural vegetation dominating the higher slopes. Immediately bordering the river are pockets of agricultural land. In both the upper and lower estuary, much of the farming community continue to occupy old weatherboard farm houses that contribute to the heritage value of the landscape as well as its scenic character.
- Expansive views. In both the upper estuary and lower estuary, extensive views of river reaches are available from the banks (e.g. from The Grotto, from foreshore reserves in Nowra, from roads along the lower estuary, from places within Shoalhaven Heads village (**Plate 4.2**) and Crookhaven Heads/Orient Point).
- Still protected waters. In the upper estuary in particular, the enclosed nature of the waterway provides for very still water surface, reflecting the sandstone cliffs and vegetated bluffs adjacent to the river.
- Areas of estuarine wetland that create the visual catchment of popular boating areas in the lower estuary. These areas feature mangrove forest, backed by saltmarsh and are frequented by diverse wader species.
- Relatively low key, “holiday” feel associated with even heavily used foreshore reserves (e.g. at Greenwell Point), often linked to the traditional boating, fishing and oystering uses of the waterway.

Whilst some of these visual qualities are shared by other south coast lakes and estuaries, many are unique to the Shoalhaven River estuary, because of the size of the system and the juxtaposition of gorge and floodplain country. The Shoalhaven is a large river estuary, only repeated on the south coast by the Clyde river system. However, the Clyde is not in sandstone country and does not have the extensive coastal floodplain that is an important feature of the Shoalhaven landscape.

4.2.1 Threats to the Visual Quality of the Landscape

The landscape values of the Shoalhaven River estuary are rare on the NSW south coast. The landscape character is threatened by both natural processes and land use change, including the following issues:

- Intensification of village development changes the nature (scale) of foreshore development, with larger houses or new areas being added to the urban footprint. At the local scale, intensification of use may also result in increased litter in foreshore reserves, or increased demand for waterfront structures such as sea walls, jetties and moorings (e.g. see **Plate 4.3**).
- Ongoing bank erosion in the lower estuary. Although bank erosion and changing channel form are long standing features of the estuary, escarpments associated with major bank retreat can affect the quality of views across the low relief sections of the floodplain.
- Increased boating traffic – particularly in the upper estuary. This is as much a sound amenity issue for other waterway users as a visual amenity issue.
- Changes to the nature of riverbank vegetation. Much of the visual character of the Shoalhaven River estuary is determined by a lack of riparian vegetation and by discontinuous floodplain vegetation communities. This relatively open, low vegetation is a historic feature, resulting from clearing and grazing on the floodplain and changes to floodplain drainage. For habitat reasons, there is a strong case for restoring natural wetland and riparian vegetation. Whilst important ecological values would be restored, there is an indirect potential loss (change) of visual character.

4.3 THE VALUE OF STABLE RIPARIAN ZONES

As noted in **Sections 1** and **4.3.1.2**, the Shoalhaven River estuary is a dynamic natural system. The alignment of the main channel, the pattern of accretion and erosion in the channel and the width and depth of the channel have all changed greatly over a period of thousands of years. Notwithstanding this, the condition of the riparian zone of the Shoalhaven River estuary is currently poor, due to a combination of removal of river bank habitats and moderate to severe bank erosion in several places.

4.3.1 Threats associated with Geomorphic Processes

4.3.1.1 Upper Estuary

In the upper estuary, bank erosion is focused on the margins of floodplain pockets (see **Figure 4.3**). Other parts of the channel are bedrock controlled and are stable.

The stability of the margins of discontinuous floodplain is affected by flood scour and seepage (as water levels fall) associated with flood flows from the catchment. Within the channel, sediment transport is principally driven by flood flows and tidal currents. However, at some locations, bank erosion is accelerated or augmented by two main land/waterway uses. These are noted below. There is no evidence that water extraction by Shoalhaven Water or SCA, upstream in the catchment, presents a threat to bank stability in the upper estuary.

Processes augmenting bank erosion, upper estuary

- wash or waves created by boats travelling at speed (but not planing), or close to the bank; and
- cattle trampling and grazing on the bank face and into the river. Cattle trampling and grazing remove grass cover, prevent or reduce the rate of recovery of natural vegetation, tend to spread weeds and may also remove fringing reed beds from along the base of the bank. This poorly managed cattle grazing contributes to both bank instability and reduced biodiversity. Where cattle graze or drink in the river (salinity permitting in the upper estuary), they also have the potential to degrade local water quality.

4.3.1.2 Lower Estuary

The lower estuary, downstream of Nowra (or downstream of the Bomaderry Creek junction), is a dynamic geomorphic environment, with system wide adjustments to tidal and catchment flows continuing to take place. Large scale migration of the thalweg of the main Shoalhaven estuary (between Bomaderry Creek and O'Keefes Point) has been described by several bank erosion studies (see Umwelt 2005 for a summary of previous bank erosion assessments).

The Healthy Rivers Commission (1999) convened an Expert Panel to review erosion in the lower estuary and the relationship between flows through Berrys Canal and closure of Shoalhaven Heads in particular. The extent of the long term adjustments to channel gradient, cross sectional area and thalweg in the lower estuary prompted the Expert Panel and the Healthy Rivers Commission (1999) to conclude:

'the degree of uncertainty associated with such a morphologically dynamic environmentin alluvial environments in general, and on coasts in particular, geomorphic hazards are more readily predicted than the geomorphic responses to physical interventions (hard engineering works). Such interventions can result in severe and unexpected impacts (erosional, depositional and biological). Consequently risks emanating from the existing hazards must be sufficiently dire to justify undertaking works that may initiative new uncertainties and adverse impacts.

In lay terms, major attempted intervention would cost a great deal, is unlikely to resolve perceived problems and is very likely to create new problems and uncertainties. Since the natural forces cannot be contained, and would be difficult to guide, the Commission believes agency and Council efforts should promote better understanding of those forces by the local community, in order for citizens to be able to live with the consequences."

In the view of the HRC, the management of bank erosion and channel change in the entire lower estuary is an issue where sustainable management is most likely to imply living with change and uncertainty, rather than attempting to maintain a specific channel form or channel location (see recommendation (c), p 202 : *"The Commission strongly recommends the adoption of appropriate planning and hazard management for the entire lower estuary, which recognises the dynamic nature of this area. Issues to be addressed should include the need for development restrictions, such as building criteria and/or setbacks, property acquisition and associated equity issues.*)

Whilst there is not complete agreement between past assessments of the extent and nature of bank erosion in the lower Shoalhaven estuary, there are several sections of bank that have persistently been recognised as being affected by severe erosion (see Umwelt 2005). These critical bank erosion areas are noted in **Table 4.3**, together with a summary of information

about the drivers of erosion at each location. **Table 4.3** also describes the values that are known to be affected by erosion at each location (or could be affected if severe erosion continues). Other than at Comerong Island and Bevan Island, ecological values are not threatened by ongoing channel adjustment. There is, however, considerable potential to restore some riparian biodiversity values and enhance connectivity of riparian habitat as a corollary of a non structural response to bank erosion. Where riparian vegetation (on the bank and in channel reedbeds) is present, it reduced the impact (energy) of wind and boat waves on the bank.

SKP (1977), Hubble (1998) and Norman and Turner (1999) have all considered the effects of Tallowa Dam on downstream sediment budget, and consequent potential effects on bed and bank erosion. Most of this work concentrated on the freshwater reaches of the system, not the estuary. However, both Hubble (1998) and Norman and Turner (1999) conclude that the form of the low flow channel is determined by high flow events (which are not affected by Tallowa Dam), so sedimentology issues should not be considered only in terms of low flow management. Yalwal Creek, which is not controlled by Tallowa Dam, also contributes sediment to the estuary and sediment load increases downstream of the Yalwal Creek junction (Boyes 2006).

Although there is some uncertainty around the fine details, the evidence to date suggests that water extraction by Sydney Catchment Authority can have only a very minor role in bank erosion processes in the Shoalhaven River estuary. This is particularly the case downstream of Nowra, where tidal currents are important hydraulic drivers of sediment movement during low rainfall periods, but high flood flows are responsible for major scour. Figure 3 of Boyes (August 2006) shows the natural variability of freshwater flows into the estuary.

Table 4.3 - Locations of severe bank erosion, Lower Shoalhaven Estuary

Location	Process drivers	Values considered to be at risk
North bank, opposite Pig Island.	Moderate erosion caused by flood scour and flood induced slumping, with some contribution from tidal scour. Flood flows are forced onto the northern bank by accretion of the island. Variable soil cohesiveness. Note the location of a bedrock "bulge"/control at downstream end of eroded bank.	Adjacent to major industrial sites.
South bank between Pig Island and Numbaa Island.	Erosion is driven by a change to main thalweg, with the meander pattern inside the main channel. The thalweg has shifted to north of Pig Island, then against south bank between islands and then north of Numbaa Island.	Agricultural land on the floodplain.

Table 4.3 - Locations of severe bank erosion, Lower Shoalhaven Estuary (cont)

Location	Process drivers	Values considered to be at risk
North bank, opposite Numbaa Island (upstream and particularly downstream of Broughton Creek junction) (see Plate 4.4).	Flood scour and flood induced slumping are the dominant processes, with some contribution from tidal scour and tidally induced slumping. Sinclair Knight and Partners (SKP) (1977) and DPW (1988) suggest that Numbaa Island postdates 1822. SKP (see their figure reproduced as Figure 5.1 in Umwelt 2005) show the southern bank of the river located on the northern side of Numbaa Island in 1822, but south of Numbaa Island in 1860.	Agricultural land is immediately affected. The main road to Shoalhaven Heads is in close proximity to bank.
Bevan Island.	Primarily flood scour and flood induced slumping. There is some contribution also from tidal scour and wind waves (exposed to the south).	Agriculture/conservation of aquatic and wetland habitats.
O'Keefes Point and Berrys Canal, both banks.	Erosion of Berrys Canal is primarily caused by tidal current scour, at high velocities, in an undersized channel. O'Keefes Pont has probably been eroding since prior to Berrys Canal (in 1822), but continues on either side of an accreting high point bar. More than 80 metres of bank retreat (channel widening) occurred along Nobles Island between 1949 and 1984 (DPW 1988). A revetment placed along the southwestern shore of Comerong Island (within Berrys Canal) in the 1960s has now been destroyed by erosion (deep tidal currents).	Agricultural land at O'Keefes Point. Very high conservation values (biodiversity, threatened species, migratory waders, endangered ecological communities) along Comerong Island, Nobles Island.
Western shore of Comerong Island.	DPW (1988) estimate that the north-western margin of Comerong Island, (north of Berry Canal) receded 150 metres between 1901 and 1949. Erosion is primarily due to wind waves (large fetch to west), but the bank is also opposite accreting shoals off Old Man Island. Some sections are also affected by floods.	Very high conservation values – biodiversity – as above.

Table 4.3 - Locations of severe bank erosion, Lower Shoalhaven Estuary (cont.)

Location	Process drivers	Values considered to be at risk
Greenwell Point Reserve.	Reclaimed land, with active erosion above mean tide level, considered to be caused by wind waves. Some sections of the shore also affected by tidal scour.	Regional recreation values, safety of boat launching, swimming.

4.4 INDIGENOUS CULTURAL HERITAGE

The Aboriginal heritage of the Shoalhaven River estuary and its floodplain incorporates the following elements:

- important Aboriginal places in traditional stories (e.g. Mount Coolangatta and Crookhaven Headland);
- rock shelters and art sites in the sandstone country that borders the upper estuary;
- middens and associated stone artefacts that have been recorded on slightly elevated ground near floodplain wetlands and along the banks of the estuary and its tributary creeks;
- the Aboriginal Mission at Roseby Park (Orient Point);
- places that are associated with historical events, particularly in relation to agricultural land uses and fishing, industries where many Aboriginal people were employed in the late nineteenth and early twentieth century. Aboriginal people also maintained traditional cultural fishing and shellfishing practices throughout this period (see DEC 2005); and
- Aboriginal cultural landscapes. This concept integrates many of the above elements, but also takes into account the Aboriginal perception, understanding and attitude towards of the natural world around them. A cultural landscape value may be associated with a specific site, but also encompasses resources and outlooks in the landscape, spirituality, cultural traditions and practices etc. (e.g. see Andrews 2004).

4.4.1 Threats to Indigenous Heritage Values

Two principal issues threaten the Aboriginal cultural heritage values of the Shoalhaven River estuary and its associated floodplain:

- Poor awareness of the significance of Aboriginal cultural values amongst land use decision makers. This issue incorporates several different aspects, that range from archaeology to cultural beliefs and practices:
 - limited coverage of archaeological survey. In particular, very little is known about the archaeology of the floodplain pockets in the upper estuary;
 - significant changes in the landscape in historical times, which mask traditionally important places and have tended to destroy artefact sites;

- limited representation of Aboriginal people in natural resource and land use planning committees/forums etc. This is slowly being addressed, not only for the Shoalhaven River estuary but for all coastal systems, by increasing employment of Aboriginal people in DECC, by the sponsorship of new cultural recoding projects by DECC, and by proactive strategies to involve Aboriginal community representatives in CMA activities; and
 - much of the information about cultural values is held orally and is not recorded. This issue has been addressed in recent times by the preparation of the Report – Aboriginal Women’s Heritage Nowra (Department of Environment and Conservation 2005) and by the CCA Aboriginal Cultural Landscapes project. Both of these include a wide range of information obtained from interviews with elders in the community.
- Increasingly intense use of foreshore reserve areas, together with expanding urban development. Both of these changes to land use may lead to impacts on Aboriginal sites or on resource aspects of the cultural landscape.

The low level of engagement of Aboriginal people in planning processes is considered to be the most urgent of these issues. If communication and awareness are improved, then the risks to specific Aboriginal sites, places, landscapes and values will be reduced.

4.5 HISTORIC HERITAGE – AN EVOLVING RELATIONSHIP WITH THE ESTUARY AND FLOODPLAIN

Multiple individual buildings, but also landscapes are identified in National, State and local (Shoalhaven LEP 1985) heritage databases. The Heritage Items listed in the Shoalhaven LEP are noted in Appendix 5 of the Shoalhaven Data Compilation Study (Umwelt 2005).

As examples, virtually the entire Coolangatta Estate is listed in the Australian Heritage Database, as are the Nowra Bridge (Princes Highway) and two Indigenous Places (Register of the National Estate). Several locations are also recognised for their natural landscape values (see **Section 4.2**).

The NSW National Trust has registered several other places that have historical value, including cemeteries, burial grounds and a number of buildings at Terara. The Comerong Island Ferry is also listed by the National Trust, as are other broader landscape values (see **Section 4.2**).

Apart from these formal listings, the historic heritage features of the study area are considered to have community value because they cumulatively illustrate how the modern community of the area has evolved. The links to past lifestyles show a way of life that no longer exists in many cases, but also show the background to currently valued lifestyles associated with the estuary. The historical importance of floodplain agriculture (horticulture and dairying) and fishing are both important elements of how people appreciate the Shoalhaven landscape today.

Not listed in any of the heritage databases are the features and actions that have had a major influence on estuary processes and on the ecological health of the system. These include the construction of the training wall at Crookhaven Heads, the excavation of Berrys Canal (both in the mid nineteenth century), the construction of flood mitigation structures (floodgates, walls and drains) in the 1960s and the construction of Tallowa Dam. As noted in **Section 4.3.1.2**, the Shoalhaven river estuary continues to adjust to the hydrodynamic impacts of Berrys Canal. Flood mitigation structures have changed the nature of the floodplain landscape, particularly by reducing the area of wet back swamp.

4.5.1 Threats to Historic Heritage Values

Places that are formally listed in the National Heritage List, or in NSW or local government heritage registers have statutory protection, or must be given specific consideration in development proposals.

Places identified in the National Trust register do not have statutory protection. These are often the places that are important at the local level and have meaning for local communities rather than formal significance.

Threats to many heritage places along the Shoalhaven River estuary are primarily associated with neglect or insufficient resources for maintenance.

In the case of heritage landscapes (see also **Section 4.2**), threats are associated with land use change and increased development (e.g. changing primarily agricultural landscapes to those dominated by built forms or roads).

4.6 LOCAL COMMUNITY LIFESTYLES AND RECREATION

The relatively low level of development intensity along the Shoalhaven is valued by local people who enjoy the opportunities for low key family based recreation that the Shoalhaven River estuary provides. Residents compare the more developed north coast unfavourably with the peace and low key development of the Shoalhaven estuary and coastal hinterland. This includes, for instance, open public open space along the river bank (e.g. in Nowra and Greenwell Point) and family fishing from public jetties, with access suitable for grandparents to accompany young children. Residents enjoy the beautiful setting on the existing picnic areas and reserves and the feeling that they are not too crowded.

Local people also enjoy the accessibility of spaces that have a “wilderness” feel in the upper estuary, for swimming, fishing and unpowered boating activities. The forested visual catchment of the upper estuary is very important to this perception of remoteness, even though the river is only a short distance from the Nowra urban area.

In addition to these values for low key and passive recreation in a natural setting, some members of the community also value the protected waters of the upper estuary very highly for water skiing and wake boarding (particularly between Thompson’s Point and Gypsy Point). Currently, most users launch their vessels at the Greys Beach regional boat ramp and motor upstream (or downstream for some fishing activities) to their preferred location.

A number of local camping ground/caravan park businesses on the banks of both the upper and lower estuary are supported by visitors using the estuary for skiing, wake boarding or fishing. This is an important contribution to the economic value of the estuary.

4.6.1 Threats to Local Lifestyles

Threats to lifestyle values associated with the Shoalhaven River estuary and its coastal floodplain can be considered at two scales:

- Firstly, there are gradual changes, not specifically planned, to the population (size, age structure, aspirations, wealth etc.). These occur with infilling of development on zoned land in coastal villages, and with gradual increases in the demand for recreational facilities along the estuary. Cumulatively, these changes can make a significant difference to the lifestyle opportunities and perceptions of residents. For instance, Webb McKeown (2003) note that 20% of the residences at Greenwell Point are

unoccupied or holiday homes, many owned by people who see them as a retirement residence (40% of the population of Greenwell Point is aged 55 or over). If all of these residences became permanent homes, there would be a significant change to the weekday population and facility needs of the village.

- Regional scale strategic planning may create expectations of significant demographic, social, economic and cultural change. The draft South Coast Regional Strategy (DoP 2006) suggests overall population growth of 36% (60,300 people) in the south Coast region over the next 25 years. Many of the new households in the region will be single people, or older citizens (over 65 years in age). DoP propose that most growth will be concentrated around existing major urban centres, rather than smaller isolated villages, partly to protect sensitive environmental values. Nowra-Bomaderry will absorb about half the proposed regional growth in population (adding 34,000 people). This long term, planned increase in urban development has implications for the use and health of the Shoalhaven River estuary. For instance, rigorous controls on urban stormwater will be necessary to protect the water quality of the upper estuary. A large urban population will require robust and quality waterfront recreation facilities. Increasing local population, coupled with increasing numbers of regional and metropolitan visitors, will add pressure to recreational boating uses and facilities on the upper estuary. This suggests that in the medium to long term, upgrades of recreational facilities (river access points) and careful management of the interaction of waterway uses will be essential.

Other possible threats to regional lifestyles may occur at the local scale if diverse aspects of climate change constrain fisheries, the oyster industry or floodplain agriculture (see **Section 4.3**), or create difficult to manage erosion or safety issues at major foreshore parks.

4.7 TOURISM AND VISITOR RECREATION

The population of coastal villages in the Shoalhaven Council area increases up to five times during peak holiday periods. Whilst this is much less evident in towns and villages along the estuary, there is no doubt that key attractions for visitors to the area include the scenic beauty of the estuary, the opportunities for estuary fishing, either from the shore or from small boats and the still waters that are ideal for water skiing and wake boarding. These very calm waters are also attractive for visitors seeking a “wilderness” experience on the waterway.

The Shoalhaven Council area attracts the greatest number of overnight visitors (person nights) in non metropolitan NSW (SCC 2005). The annual estimate of visitor nights for 2003 was 4,507,000, significantly more than for other regional centres (e.g. Coffs Harbour 3,045,000, Port Stephens 2,492,000). The visitors are strongly concentrated around the Christmas-New Year holidays and Easter. Estimated expenditure by domestic overnight visitors to the Shoalhaven Council area in 2003 was \$461.8 million. Day visitors add a further \$167.1 million to this expenditure in the local economy.

Some 92% of overnight visitors are reported to be visiting the area for recreational or social (including visiting family) reasons. Whilst weekend visits (41% of recreational visits are 1 or 2 nights and 58% of friends or family visits are 1 or 2 nights) are the most important, 27% of holiday/recreational visitors are in the area for 4-7 nights. Visitors stay with friends or family, or in caravan parks (totalling 58% of person nights), with only 11% of domestic visitors staying in motels or resort accommodation.

Apart from visiting family and friends, by far the majority of visitors (49% of overnight stays and 26% of day trips identify going to the beach as their main leisure activity in the area). However, general sight seeing is also important (37% of overnight stays), 21% of overnight visitors report that their main activity was fishing and 14% state that they visited for a picnic or BBQ. The number of people reporting that they visit the area to go fishing is

three times the NSW average. These figures are consistent with DPI recreational fishing survey findings that show some 31% of south coast people participate in recreational fishing each year.

The distribution of visitors in terms of accommodation preferences and recreational activities is important for the future management of the estuary.

Council has identified Greys Beach at Nowra and the Greenwell Point Foreshore as “Icon Parks”, to be developed with a level of facilities necessary to meet the needs of tourists as well as local people. The boat ramp at Crookhaven Heads (**Plate 4.5**) is also a regional scale facility, built to cater for visitor demand as well as local people.

NSW Maritime Authority is currently preparing a Boating Management Plan for the Shoalhaven River estuary. As part of that project, they have studied boating use, interactions between users, numbers of accidents and the adequacy of facilities. Their studies confirm the high value placed on the upper estuary for both power boating (skiing and wake boarding, plus cruising for picnics and fishing) and for unpowered boating activities (canoeing and fishing). Many of these waterway users are weekend or holiday visitors. Overall numbers of waterway users are currently relatively low compared to other more urban coastal waterways, and NSW Maritime also suggests that Shoalhaven River estuary waterway users are generally very compliant with safe boating regulations. Numbers of waterway users are expected to increase in the medium term.

4.7.1 Threats to Estuary-based Tourism and Recreation

A major issue noted in recreation studies and by community members of the SNRFMC is the appropriate balance between powered and non powered recreational boating in the upper estuary. The Committee recognised existing and potentially significant future conflicts in terms of:

- the wilderness experience of the upper estuary, fringed by steep slopes of natural vegetation. The suitability of high speed power boating activity in the more remote and natural parts of the estuary has been questioned;
- noise issues for passive recreation users, including canoeists and campers; and
- safety issues when high speed vessels and non-powered vessels use the same reaches of the estuary.

There is some natural segregation of activities, with skiing and wake boarding predominantly occurring between Thompson’s Point (just upstream of Nowra) and Gypsy Point (NSW Maritime Authority) and passive boating mostly occurring close to river access points in the upper estuary (such as Bundanon and Grady’s Riverside Retreat). Numbers of passive recreational users are currently quite low.

In addition to the differences between two groups of users who both value still waters, there are some threats associated with navigation safety for powered vessels in shallow waters (shoals and submerged rocks) in the upper estuary. For non powered vessels, there may be safety issues in deep and/or fast flowing water.

As demand for recreation access grows over time, both types of activity may also be limited by insufficient ramp access, or poor accessibility of public foreshore along the river. Improved delineation of public foreshore in the upper estuary would assist in this regard.

The importance of recreational fishing in the area suggests another potential threat to tourism, linked to the productivity of the estuary and management of fishery stocks. The

maintenance of high recreational fishing participation rates depends on perceptions of pleasant fishing conditions and a high probability of making a catch. The Shoalhaven River estuary is one of very few south coast systems where recreational and commercial fisheries still coexist. Almost all the small estuaries (predominantly coastal lakes) south of the Shoalhaven River estuary, are now recreational fishing havens, where commercial fisheries have been closed. The expectation is that these recreational fisheries will produce high yields for fishing effort, potentially more than the Shoalhaven. In contrast, the Shoalhaven River estuary retains the advantage for non fishing visitors that fresh, local fish can be obtained from local co-operatives on the river bank.

4.8 PRIMARY PRODUCTION

One of the benefits of living along the Shoalhaven River estuary is being able to obtain locally grown vegetable produce (from the coastal floodplain) and locally harvested fish and oysters (from the Shoalhaven and Crookhaven). This quality local produce is also valued by visitors to the area and fish and oysters in particular help to attract tourists.

Residents also note that they value the visual qualities of a productive rural landscape, with particular reference to dairying.

Total oyster production in the Shoalhaven and Crookhaven parts of the estuary is variable. Production in the Shoalhaven lease areas in 2003-04 was 85,919 dozens, the highest production from that area over an eight year period. Production from the Crookhaven lease areas in 2003-04 was 103,454 dozens. This production was consistent with production over the preceding two years, but less than half the peak production from this part of the estuary (233,216 dozens in 1997-98). Productive leases in the Crookhaven part of the estuary declined from 229 hectares in 1996-97 to 139 hectares in 2003-04.

Sea mullet, luderick, whiting, mulloway, bream and school prawns are the major target species for the Shoalhaven commercial fishery. The estimated catch value from the commercial fishery is around \$500,000 each year, with total catches ranging from 105,000 kg to about 140,000 kg annually.

DPI surveys indicate that the NSW south coast has the largest number of recreational fishers in the State, with more than 500,000 recreational fishers using the estuaries each year.

4.8.1 Threats to Primary Production

The viability of commercial fisheries of the estuary is affected by a range of factors that together degrade or reduce fishery habitat. These factors include:

- constraints to fish passage from the main estuary into wetlands and sheltered estuarine tributaries, both of which provide habitat for juveniles. Floodgates are a major issue, but culverts and other structures can also block fish passage;
- drainage of floodplain wetlands, or conversion of former estuarine wetlands to intermittently fresh systems;
- low pH discharges from acid sulfate soil areas. Slugs of acid water have been recorded discharging from floodplain drains during wet weather events, with the Broughton creek floodplain particularly affected. Apart from the direct chemical toxicity of low pH water (causing lesions and/or fish kills), acid water can also act as a chemical barrier to fish passage (for instance, trapping juvenile fish in the upper estuary, in low dissolved oxygen conditions);

- reduction in the area of saltmarsh or changes in the balance between saltmarsh and mangrove habitat;
- significant variations in rainfall and flows in the estuary: for instance in extended dry periods the upper estuary becomes progressively saline, modifying fishery habitat; and
- future changes in climate and sea level could also threaten the fishery, for instance by increasing storminess (fewer fishing days available) or by changing the pattern of wetland habitats.

In addition to these habitat considerations, the commercial fishery is also affected by economic factors, such as fuel prices, by competition from overseas fisheries, and by regulations that restrict fishing times or areas. Whilst these regulatory actions are implemented to enhance the potential for long term sustainability of fish stocks, they can have short term detrimental impacts on fishing businesses in the industry now. Over time, it is anticipated that the balance between healthy fishery habitat, short to medium term fluctuations in flow and water quality, inherited over fishing impacts, and the number of licensed fishers will be rationalised.

Threats to the viability and sustainability of the food oyster industry have been recognised in estuaries throughout NSW. DPI has conducted research and analysis into water quality issues affecting the quality of oyster produce and has identified specific locations within estuaries that are most at risk or are least threatened by land and waterway use pressures.

Consultation with oyster growers in the Shoalhaven River estuary (primarily around Greenwell Point and the lower Crookhaven River) indicates that the major issues from the perspective of growers are:

- impacts on biological water quality when discharges or spills occur (e.g. from sewage reticulation systems or from vessels), or during periods of wet weather runoff from adjacent urban areas;
- the high cost of monitoring required to be conducted by oyster growers to meet QA standards. Oyster growers monitor shellfish quality at thirteen sites and water quality at twenty three sites in the lower estuary. Phytoplankton is also monitored at two sites (see **Figure 4.3**);
- an increase in recreational boating pressure adjacent to lease areas (or in lease areas), which increases the risk of contamination;
- potential increases in hot days resulting in overheating (heat kill) of exposed oyster stock in summer. This is particularly an issue when very hot days coincide with low tides in the middle of the day. Heat impacts can be managed by shading and irrigation of the oyster trays. Pumping of water to irrigate oyster trays in hot weather currently occurs on several days each summer in the Shoalhaven. Some leases in the Crookhaven/Greenwell Point area are close to residential areas. In these leases, diesel pumps may not be acceptable for tray irrigation because of noise impacts on adjacent land users;
- storm wave and wind damage to trays, racks and leases (e.g. strong winds can blow trays off the racks on leases);
- general increase in water level as sea level rises. In general, this can be accommodated by using floating cultivation techniques (rather than the traditional fixed racks);

- changes to water chemistry if temperatures rise. These changes may affect nutrient dynamics and also affect the incidence of algal blooms etc in the estuary. Oyster harvesting is required to cease during serious algal blooms; and
- poor housekeeping by oyster growers may lead to clean up notices potentially expensive works to achieve compliance.

The production of the fishery may also be impacted by long term climate change, although the effects on water chemistry and biological activity have not been fully specified.

4.9 ASSETS FOR GROWTH AND DEVELOPMENT

The population of the south coast region is 166,000 and has doubled over the last 25 years. Approximately half of this population lives in the Shoalhaven City Council area. Nowra, Bomaderry, Vincentia and Ulladulla are all significant regional centres.

The size of Nowra and Bomaderry and the concentration of regional industry in these centres are assets that will contribute to regional growth

However, the natural assets of the Shoalhaven river estuary are also important contributors to regional growth, by attracting population. The draft South Coast Regional Strategy (DoP 2006) suggests that the region will attract another 60,000 people over the next 25 years, many of whom will be “Sea Changers”, seeking lifestyles in coastal villages and urban centres that still provide good access to services and facilities such as schools and hospitals.

4.9.1 Threats to Resources for Regional Growth

The draft South Coast Regional Strategy states that development in the region over the next 25 years will deliver diverse communities and housing opportunities, increase employment and encourage community interaction and cohesions. The draft Strategy also sets parameters for how development will proceed. The inverse of these parameters can be seen as potential threats to regional growth. These constraints also have the potential to threaten existing natural and social values.

Examples include:

- potential limits on land that is suitable for development, because of the need to protect the catchments of sensitive waterways, avoid land subject to flooding, avoid urban development adjacent to mosquito habitat, and concentrate development around existing centres;
- potential impacts of increased permanent population on the tourism values of the region;
- potential impacts of expanded residential areas on scenic landscapes; and
- potential for urban expansion to increase impacts on places that have aboriginal cultural heritage values.

4.10 CLIMATE CHANGE

CSIRO (2001) and the Australian Greenhouse Office (Pittock, 2003) describe the potential impacts of climate change on urban and coastal landscapes and communities in south eastern Australia. Apart from sea level rise, the threats reported include changes to the frequency

and duration of extreme weather events, such as gales, storm surges, droughts and floods. The potential health impacts of extensions to the range, or increased breeding success of mosquitoes has also been noted.

Examples of current trends include:

- predicted average warming of 0.4 to 2 degrees Celsius by 2030 and 1 to 6 degrees Celsius by 2070 (compared with 1990 conditions), combined with more hot days (over 35 degrees Celsius) and generally warmer spring conditions;
- a continuation of the trend since the mid 1990s for rainfall to be below average to severely deficient in south eastern Australia, when compared with long term averages, with the most pronounced deficiencies in rainfall occurring in winter and spring; and
- sea level rise of 0.1 to 0.4 metres within 50 years (IPCC and CSIRO 2001), accompanied by potential increases in coastal storminess (storm waves) and the frequency of gale force winds. Note that existing records from coastal gauging stations show an average increase in sea level of 20 mm per decade over the last 50 years (CSIRO 2005).

Whilst these general impacts have relevance to the Shoalhaven estuary and its community, the level of detail of regional climate predictions is not currently sufficient to provide confident predictions. Indeed, for many of these potential changes, there is no local scale modelling or research available to indicate the potential range of change. The types of impacts which climate change could facilitate in the Shoalhaven River estuary include:

- landward migration of mangrove communities as sea level rises (although potential migration pathways may be blocked by other land use or land management constraints);
- landward migration of saltmarsh communities - these are even more constrained than mangroves, because of the requirement for very gentle shoreline gradients and less opportunistic colonisation of sand and mudflats. On steeper shoreline gradients, saltmarsh habitat could be rapidly inundated;
- changes to the salinity of the upper estuary, both from increased tidal incursion and during extended drought periods. Persistent salinity changes would modify/migrate various elements of aquatic ecology;
- changes to the frequency and severity of flood events;
- changes to the suitability of the estuary as roosting, feeding or breeding habitat for migratory waders and other bird species;
- changes to the strength and/or frequency of tidal current scour and flood scour. These changes may affect the location and severity of bank erosion and sedimentation in the estuary. Increased bank erosion pressure in the estuary would also have implications for the success of riparian revegetation programs, including the re-establishment of reed beds and upper bank species such as casuarina;
- changes to floodplain aquifers and associated floodplain wetlands, as well as water for agriculture and the mobilisation of acidity currently stored in floodplain soils (ASS and PASS) into drains and the estuary;
- changes to the effects of storm surge, particularly in the lower estuary;

- an increase in the risk of high temperatures, together with changes to the tidal regime, has implications for the viability of the oyster industry – such as exposure of oyster stock to overheating or changes to the success of spat setting;
- changes to estuary and coastal biochemistry, affecting the fishery resources of the area;
- changes to the epidemiology of mosquito transmitted diseases;
- changes to the sediment flux into the upper estuary, associated with changes to catchment rainfall and catchment erosion; and
- changes to the areas that are suitable (safe in terms of water depth) for recreational boating.

As noted, there is little information on which to base an assessment of the significance of these potential impacts and risks. Based on the existing evidence of systemic adjustment to changes to the entrance and the construction of Berrys Canal, potential long term changes in the Shoalhaven river estuary, whilst uncertain, are likely to be significant. **Sections 6.2** and **8.5** of the Estuary Management Plan discuss an approach to the management of these uncertain impacts.

5.0 MANAGEMENT PLAN OBJECTIVES AND OUTCOMES

This section develops a suite of estuary management objectives and related outcomes for the Shoalhaven River estuary. Objectives of relevance to the natural, socio-cultural and economic values that contribute to the sustainability of the estuary have previously been prepared as part of Council's strategic planning program, the Healthy Rivers Commission report, draft Catchment Action Plan, South Coast Regional Strategy and other regional natural resource management documents.

The proposed objectives for the Estuary Management Plan draw on this previous work and the understanding of estuary values and processes established in the Data Compilation Study (Umwelt 2005). The intent is that the estuary management objectives are realistic and integrative.

These new estuary management objectives are taken forward into the identification and assessment of potential management responses in **Sections 7, 8, 9 and 10**.

5.1 A VISION FOR THE SHOALHAVEN RIVER ESTUARY – HOW WILL THE ESTUARY BE IN THE FUTURE?

The following six statements summarise the overall vision for the Shoalhaven river estuary, based on scientific and community views about the values of the system:

- a place of high biodiversity;
- a place where the community understand and contribute to natural resource conservation in their day to day activities;
- a place that is known for its high quality aquatic and agricultural produce;
- a place that is accessible and safe for locals and visitors;
- a place where development scale does not overwhelm the natural landscape; and
- a place that can successfully adapt to long term environmental change (socially, ecologically and economically).

5.2 COUNCIL'S PRELIMINARY ESTUARY MANAGEMENT OBJECTIVES

Council intends that the estuary plan will integrate with other existing natural resource management plans at the objective level. In the brief for the preparation of the Estuary Management Plan, Council proposed the following generic objectives for the estuary:

Water Quality

To ensure that water quality in the estuary is adequate for the protection of aquatic ecosystems, visual amenity, primary contact recreation, secondary contact recreation and consumption of cooked seafood (as per NSW Interim Water Quality Objectives).

Erosion and Sedimentation

To minimise the erosion of soil from the catchments and creek banks and to protect the estuary from excessive sedimentation.

Nature Conservation

To maintain or where appropriate restore the ecological integrity and biodiversity of the estuary, foreshores and catchments.

Entrance Management

Alleviate flooding impacts on Shoalhaven Heads and Greenwell Point (see entrance management plan).

Recreation

To ensure that recreational activities do not have undue effects on the nature and enjoyment of the area.

Visual

To maintain, rehabilitate where necessary and enhance where appropriate the high visual qualities of the estuary.

5.2.1 Review of Preliminary Objectives

Following the review and update of the Shoalhaven Data Compilation Study (Umwelt 2005), the management objectives listed above required further consideration.

Matters that have been considered include:

- The regional context for overall protection of values in the Shoalhaven and other south coast estuaries. It is also important to consider the position of the Shoalhaven catchment in contributing to the sustainability of the Greater Metropolitan Region (e.g. through the provision of drinking water to the Sydney metropolitan area).
- Outstanding values of the Shoalhaven estuary (which are rare or poorly replicated elsewhere). The Shoalhaven estuary, for instance, contains highly significant habitat for migratory waders and very extensive areas of saltmarsh when compared with other south coast estuaries.
- Objectives should be realistic in relation to the natural system processes that occur in the estuary. They should relate specifically to this system, whilst reflecting its regional context.
- There is a need for systemic objectives that address how decisions will be made, reviewed and implemented. These include matters such as integration, transparency, accountability, cost effectiveness and minimising duplication. The actions recommended by the Plan must also be adaptive to improved science when it is available.
- Sustainable management of the estuary goes beyond natural resource management issues and it is essential that objectives relating to social, economic and cultural values are included.
- Objectives about amenity should be clearly linked to values expressed by the community and managers.

- It is important that the objectives are identified in positive statements, rather than “do not” statements – objectives should be a statement of what Council and the community want/intend to achieve.
- Objectives should provide definitive requirements. For instance, wording such as “ensure” or “give effect to” is more direct than “take into consideration” or “implement where possible” (see HRC 1999), setting a higher standard of commitment and accountability for stakeholders.
- Objectives are best stated in association with a measurable target, so progress can be measured.
- Objectives should be consistent with (or help to refine) Council’s existing statements of values, sustainability policy direction etc (see **Section 3.1**).

5.3 GOALS FOR THE SHOALHAVEN RIVER ESTUARY

Sections 5.4 to 5.7 present a range of management objectives in relation to each of the major management themes (see **Section 2.4**) for the Shoalhaven River estuary. For each objective, these sections also provide brief statements explaining why the objective is included and describing the relevant acceptable outcome(s). These outcomes describe the future character of the estuary. A selection of quantifiable targets is shown in **bold**.

In keeping with Council’s Vision Statement, the recommendations of the Natural Resources Commission and the Southern Rivers draft Catchment Action Plan/Investment Strategy, the broad outcomes that the Estuary Management Plan will support, in association with other natural resource and regional planning documents include:

- an improvement in the assessed status of estuary integrity and health, as measured by Ecological Integrity Indices (based on the National Land and Water Resources Audit);
- maintenance or enhancement of regional lifestyle in terms of employment opportunities, aesthetic and recreational values (access to the river and adequacy/safety of facilities); and
- a level of regional population growth and a style of urban development that is consistent with maintenance/enhancement of the natural and cultural assets of the estuary and respects inherent natural threats in the system (e.g. flooding and long term geomorphic change).

The Estuary Management Plan will also contribute to the protection of environmental flows (fresh water and marine), that mimic natural conditions as closely as possible. This outcome is currently being investigated and negotiated by Sydney Catchment Authority, Southern Rivers Catchment Management Authority and other stakeholders, as it must also be balanced with the provision of a sustainable supply of potable water to regional settlements (Shoalhaven Water customers) and the Sydney Metropolitan Area.

5.4 OBJECTIVES TO PROVIDE A CLEAR MANAGEMENT DIRECTION FOR THE SHOALHAVEN ESTUARY

These objectives and outcomes define a clear decision making processes, the integration and co-ordinated implementation of estuary management actions. They also address the adaptive nature of estuary management.

5.4.1 Integration and Accountability

5.4.1.1 Integration with Regional Natural Resource and Strategic Land Use Plans

Objective:

To integrate the estuary management plan with regional scale natural resource management and regional land use strategies.

<p><i>Explanation</i></p> <p>SRCMA co-ordinates the implementation of natural resource management initiatives across the region, including ongoing monitoring and review of estuary health against State benchmarks. SRCMA does not do this monitoring itself.</p> <p>The Estuary Management Plan is identified as one of a suite of detailed plans which provide guidance on natural resource management for specific parts of the Shoalhaven Catchment. These detailed plans are intended to be complementary and to set up investment in natural resource management that produces the best outcomes for the catchment as a whole.</p>	<p><i>Indicators of satisfactory outcome</i></p> <p>Estuary Management Plan is adopted by SCC and accepted by the SRCMA.</p> <p>Implementation is supported and monitored by SRCMA.</p> <p>State government financial support is available for highest priority actions.</p> <p>Regular communication during Estuary Management Plan implementation between SCC and SCA re environmental flow management.</p> <p>The settlement strategy for the Shoalhaven region (South Coast Region Planning Strategy) reflects values and risks associated with the estuary.</p>
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5.4.1.2 Feasible Implementation

Objective:

To develop estuary management strategies which are within Council, agency and community financial capacity for implementation. Strategies depend on a realistic level of awareness, technical skills and commitment.

<p><i>Explanation</i></p> <p>Although successful estuary management depends on the co-ordinated actions of multiple agencies and organisations, council has a central role in terms of the scope of their relevant responsibilities. Council also has other important demands that compete for its limited resources. The implication for estuary management is that actions must be well justified and structured in a manner that can attract suitable funding. Funds can be obtained either by taking priority within Council's budget, or by actions being seen as critical at the regional and state level, so that agency commitments are translated into on the ground activity.</p>	<p><i>Indicators of satisfactory outcome</i></p> <p>Key actions are costed at a level that provides sufficient certainty for funding and budgetary processes.</p> <p>Key actions are packaged in a way that demonstrates their significance and justification, at both technical and political levels.</p> <p>Actions that require State input are clearly identified.</p>
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5.4.1.3 Decision Making Processes

Objective:

To base decisions about investment in estuary management activities on full assessment of ecological, economic and socio-cultural risks, costs and benefits.

<p><i>Explanation</i></p> <p>This objective stresses the integration of costs for works with costs and benefits that can only be measured in qualitative terms but may be very important. The intent is to use the full range of values and threats to identify both appropriate management responses (level of intervention) and the priority of those responses. This makes the decision making process more transparent and assists communities to understand why funds are invested in one part of an estuary and not in another (or in separate estuaries). The decision making process should be consistent and repeatable.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>Community feedback on satisfaction with the explanation of management decisions and investment.</p> <p>Documentation of estuary management decisions clearly demonstrates what information has been taken into account, how different issues or threats have been weighted, how risks have been calculated.</p> <p>Improved capacity of estuary managers to obtain funds for key projects.</p>
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5.4.1.4 Accountability for Implementation

Objective:

To implement accountability processes, as recommended by Healthy Rivers Commission.

<p><i>Explanation</i></p> <p>A persistent criticism of Estuary Management Plans (see multiple comments in HRC reports for the Shoalhaven and other estuaries) is that in most cases there is no obligation on responsible stakeholders to implement the recommended actions. HRC introduced Statements of Intent which it subsequently audited (e.g. for the Shoalhaven system).</p> <p>Low levels of accountability for government actions also reduce community confidence that important natural resource issues have been understood and can be addressed.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>Agencies with responsibilities for the implementation of actions in the Estuary Management Plan are required to provide updates on progress/impediments to progress in implementing the actions and also about the environmental improvement that has been achieved (reported against benchmarks). Non achievement must also be explained/justified. These updates are to be publicly available.</p> <p>The overall status of the Estuary Management Plan and estuarine health are to be reviewed and reported at ten year intervals (consistent with targets of the Catchment Action Plan)</p>
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5.4.1.5 Community Participation or Engagement

Objective:

To provide local communities with good access to information about the health of the estuary and real opportunities to contribute to decisions about the management of estuary values.

<p><i>Explanation</i></p> <p>Existing and future local communities are the people who will have to live with the results of decisions that are made about natural resource management. To a large extent, their support is also critical to the implementation of the Estuary Management Plan, both directly (in terms of capacity and willingness to act in a specified manner) and indirectly, in terms of political support for investment in identified estuary management priorities and the provision of incentives or financial/regulatory disincentives for certain actions.</p> <p>Accessible information and inclusive decision making are the keys to maintaining community support, through understanding.</p>	<p><i>Indicators of satisfactory outcome</i></p> <p>Regular provision of information about estuary management and estuary condition in Council State of the Environment Reports and in the reporting mechanisms of the CMA.</p> <p>Estuary information is available in both electronic (internet) and hard copy form, to meet the needs of different age groups and social/cultural affiliations in the community.</p> <p>Ongoing diverse community representation (including members of the Aboriginal community – see also Section 5.7.3.2) on Council’s natural resource committees, supplemented by other face to face opportunities for information exchange on specific issues.</p> <p>Feedback from the community on individual investment strategies or the application of incentives.</p>
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5.4.1.6 Ongoing Review and Adaptation

Objective:

To review the integration, appropriateness and benefits of estuary management activities regularly and adapt measures to take into account new information about processes or environmental health.

<p><i>Explanation</i></p> <p>The estuary is a very dynamic system and understanding of physical and ecological processes continues to evolve. Community aspirations and preferences may also change over time.</p> <p>Some actions have the potential to have unforeseen side effects that may impact on other values in unexpected ways. The review process allows these matters to be considered in perspective.</p> <p>Options for the timing of reviews of processes, values and responses will depend on review timeframes for the broader Catchment Action Plan and NLWRA.</p>	<p><i>Indicators of satisfactory outcome</i></p> <p>Reviews of estuary management are conducted within timeframes that are consistent with reviews of overall catchment management outcomes.</p> <p>Reviews of estuary management incorporate information from monitoring of key indicators of estuary condition.</p> <p>Information about lessons learnt about estuary responses to various types of management intervention is available for future managers and managers of other south coast estuaries.</p>
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5.5 OBJECTIVES FOR MORPHODYNAMIC PROCESSES

This section presents objectives and outcomes relating to the key physical processes and character of the estuary. In each case, the wide natural variability of flows in the Shoalhaven, and the dynamic nature of the channel plan form are important considerations. Sustainability in this case does not necessarily equate with stability.

5.5.1 Objectives for the Riparian Zone

The estuary riparian zone is the location where integration of three of the key management themes (morphodynamic characteristics, biodiversity and productivity/community

enjoyment) is critical. In developing objectives for the estuary, a number of important features of the riparian zone of the Shoalhaven River Estuary need to be taken into account. These are discussed below.

5.5.1.1 Bank Erosion and Channel Stability

Nearly all existing natural resource documents for the Shoalhaven River catchment refer to *stable banks* as an objective for managing the riparian corridor.

However, the studies that have been conducted of channel morphology and stability in the lower Shoalhaven estuary (downstream of Nowra) suggest that this system is naturally anything but stable. There is clear evidence of long term (beyond historical records) major channel realignment downstream of Nowra – with the Crookhaven River abandoned for a straighter and wider Shoalhaven River channel. There is also clear morphological evidence of long term and continuing adjustments to the alignment of the Shoalhaven river estuary channel – with the section around Pig Island moving north and the next section downstream moving south. The geomorphic and stratigraphic evidence suggests that this migration appears to have been occurring even prior to the excavation of Berrys Canal.

Further, assessments of channel size and flow dynamics indicate that in the lower estuary, the Shoalhaven channel is oversized when compared with the Crookhaven channel and with the current capacity of Berrys Canal. Under most conditions, Berrys Canal and Crookhaven Heads carry most of the estuarine flows (tidal and rainfall driven). Berrys Canal, in particular, is still adjusting to this situation and will continue to adjust for decades.

The Shoalhaven River is affected by low recurrence interval, very large floods, which, when they interact with low cohesion banks, can have major impacts on the plan form of the channel and on bank erosion.

Given the geomorphic history and current condition of the Shoalhaven River estuary, a “stable” channel is not a realistic general objective for the Shoalhaven estuary downstream of Nowra, in the sense that a “stable” channel implies a relatively fixed position (plan form), limited bed or bank erosion (or deposition), and maintenance of the status quo in terms of usage of the adjacent floodplain margin.

Although channel stability cannot be expected in a naturally dynamic system, accelerated bank erosion (driven by catchment changes or intervention in natural processes) presents a significant threat to important values. These values may include biodiversity (a migrating channel may threaten rare occurrences of an Endangered Ecological Community or habitat for nationally significant species), or recreational values (where bank erosion threatens important foreshore parks and facilities, or the safety of waterway users), or productivity values (where bank erosion or channel migration impact on valued floodplain land uses or fishery habitat), or infrastructure investment.

Management of the banks of the estuary to maintain a well vegetated interface that is robust enough to withstand small flood events, tidal currents and waves is a more appropriate objective for the estuary. Banks with healthy native vegetation communities contribute to the biodiversity values of the estuary and floodplain (aquatic, riparian). Well vegetated banks are more resistant to erosive processes (e.g. reed beds provide a buffer against mobilisation of bank sediments by wind waves or boat wash). In this context, riparian revegetation programs along the banks of the estuary should be seen as addressing firstly a local and regional biodiversity objective, with a secondary objective of reducing bank erosion or channel change.

This is not to suggest that revegetation and stabilisation of banks will not be suitable as an objective in the freshwater catchment of the Shoalhaven River. Stable banks and vegetated

banks and slopes in the catchment may influence changes to flood peakiness and velocities, etc and may over time address the oversize issue for the main Shoalhaven River channel.

5.5.1.2 Channel Change

Objective:

To respond to ongoing channel migration in accordance with risks to important ecological, productivity and amenity values.

<p><i>Explanation</i></p> <p>Geomorphic analysis indicates that the channel of the Shoalhaven estuary is not static or stable at a system wide level. Channel dynamics at this time and spatial scale may be beyond the scope of intervention. A more realistic approach is to protect key estuary values and adapt as necessary.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>Community satisfaction with decisions about investment in bank protection works. Community accepts that in some locations, retreat is the only viable option.</p> <p>Estuary bank management includes a range of responses which are demonstrably tailored to the balance between environmental/socio-economic risk, the benefits that could be obtained and the cost of intervention.</p>
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5.5.1.3 Bed and Bank Stability

Objective:

To control activities that drive bed and bank erosion outside the anticipated impact of natural flow variability.

<p><i>Explanation</i></p> <p>Whilst much of the bank erosion in the lower Shoalhaven is associated with system scale channel change (e.g. driven by tidal currents), or scour and slumping associated with flood events, some erosion in the upper estuary and at specific sites in the lower estuary is associated with boating waves, cattle access (grazing of riparian vegetation and trampling of banks) etc.</p> <p>This objective is designed to ensure that impacts directly attributable or exacerbated by waterway usage are controlled/mitigated.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>Bank erosion in high usage recreational boating areas occurs principally during floods and is stable during recreational uses.</p> <p>Where the floodplain land use is cattle grazing, bank stability is not compromised by trampling, tracks or removal of vegetation.</p>
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5.5.1.4 Sedimentary Processes

Objective:

To maintain rates of sediment transport, and localised in-channel erosion/deposition within the range anticipated with the natural flow variability of the Shoalhaven River system.

<i>Explanation</i>	<i>Indicators of satisfactory outcome</i>
<p>This is most conspicuously an issue in the lower estuary, downstream of Bomaderry Creek (i.e. Management Zone 3). Historical accretion has been reported around Pig Island and Numbaa Island as well as adjacent to Old Man Island. In each case, the accretion is linked to long term changes in thalweg (channel plan). The intent of this objective is that land and waterway uses (including flow management) do not significantly increase the risk to estuary values in these areas by changing erosion and sedimentation regimes (location or severity).</p>	<p>Erosion and accretion patterns are consistent with modelling of flood events and tidal processes, not exacerbated by other local factors.</p>

5.5.2 Environmental Flows

5.5.2.1 Flow variability

Objective:

To maintain the range and pattern of freshwater flows into the estuary within natural variability (in terms of high and low flows, seasonality, wet and dry months, rates of flood rise and fall).

<i>Explanation</i>	<i>Indicator of satisfactory outcome</i>
<p>The Shoalhaven River has highly variable natural flows, which contribute to its morphodynamic and ecological character and health. The river experiences floods at the “catastrophic” scale, but also experiences extended periods when there is little or no freshwater flow into the upper estuary, leading to elevated salinity. The scouring effect of major floods is critical for sediment transport in the upper estuary but also for occasional opening of Shoalhaven Heads. There are also multiple intermediate scale “freshes”, which influence salinity in the upper estuary, with limited affect on the lower estuary.</p> <p>The balance between tidal flows and freshwater flows is expected to change gradually as sea level rises.</p> <p>Extraction of a higher proportion of high flow events for water supply purposes has the potential to change flushing and sediment transport regimes in the estuary.</p>	<p>Water quality, geomorphic processes, aquatic ecology in the estuary and inundation of flood plain wetlands (mid flow levels in particular) are maintained within the range that can be accounted for by long term rainfall variability, rather than water extraction.</p> <p>The manipulation of environmental flows by water extraction does not result in cumulative impacts on river (estuary) productivity and condition.</p>

5.5.2.2 Flooding

Objective:

To determine appropriate management responses for flood prone areas on the basis of risk to infrastructure assets and safety, acknowledging long term trends in flooding processes and hazards.

<i>Explanation</i>	<i>Indicator of satisfactory outcome</i>
<p>Parts of Terara village, Greenwell Point and Shoalhaven Heads are constructed within floodways or are on the floodplain and are flood prone. Planning responses and emergency response procedures may be more appropriate to manage flood risk than construction of levees or other structural solutions.</p> <p>Parts of the Bolong and Riverview Road industrial areas are also affected by floods.</p>	<p>Procedures set out in the Floodplain Management Manual have been followed to identify flood risks and appropriate management responses.</p> <p>The number of properties subject to flooding hazards in the flood prone villages does not increase.</p> <p>Emergency response plans provide safe egress for residents and business employees during major flooding events.</p>

5.5.2.3 Entrance Condition/Processes

Objectives:

To maintain a regime of minimal intervention in the opening and closing of the entrance at Shoalhaven Heads.

To maintain a safe navigable channel at Crookhaven Heads.

<i>Explanation</i>	<i>Indicator of satisfactory outcome</i>
<p>Shoalhaven Heads is frequently closed by shoaled sand and incipient foredune build up, only opening in association with major flood events in the system. A number of highly valued ecological communities occur adjacent to Shoalhaven Heads (beach and estuary) and the area also provides safe recreational waters. Both of these values could be compromised by a permanently or frequently open entrance. Crookhaven Heads is maintained permanently open by a rock training wall and provides commercial and recreational boating access to the estuary.</p>	<p>An Entrance Management Policy is established and implemented for Shoalhaven Heads.</p> <p>Intervention in the opening of Shoalhaven Heads occurs only in specific agreed circumstances.</p> <p>The training walls at Crookhaven Heads are maintained to provide safe and stable entrance conditions for small commercial and recreational vessels.</p> <p>No boating incidents in the estuary are caused by unsafe navigation conditions in the main (marked) boating channels.</p>

5.5.2.4 Sea Level Change

Objectives:

To maintain awareness of best estimates of sea level change and of estuary values that are threatened by rising sea level superimposed on other impacts.

To focus conservation efforts on buffers around vulnerable habitats where terrain would facilitate habitat migration in response to sea level rise.

To focus conservation efforts on vulnerable habitats that are unlikely to be lost due to sea level rise (this requires that other impacts on sustainability are controlled).

<p><i>Explanation</i></p> <p>Current best estimates of sea level change along the NSW coast are approximately 0.5 m over a minimum of 50 years. Salt marsh communities are particularly vulnerable to sea level change, as is habitat for migratory waders (with little opportunity for habitat to adapt to inundation). This objective aims to focus conservation management on examples of at-risk communities that are least vulnerable to the effects of sea level changes.</p>	<p><i>Indicators of satisfactory outcome</i></p> <p>Quality records are maintained of changes in sea level/tidal range in the Shoalhaven estuary and tributary tidal creeks, to refine the accuracy of local predictions and keep the community informed of actual trends.</p> <p>The condition of saltmarsh in existing conservation management is maintained or enhanced.</p> <p>Habitat for migratory waders is protected and conserved wherever possible.</p> <p>Locations where saltmarsh and other vulnerable communities have potential to retreat or migrate landward (as sea level rises) rather than be eliminated, are protected and managed for conservation. (see also Biodiversity Objectives in Section 5.6).</p>
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5.6 OBJECTIVES FOR BIODIVERSITY

Biodiversity objectives relate to both terrestrial and aquatic communities/habitats, within the estuary, in the riparian zone and in floodplain wetlands. A key characteristic of the current condition of the Shoalhaven River estuary is the low biodiversity in floodplain and riparian zone contexts. The Healthy Rivers Commission (1999) noted as a priority recommendation the development of consistent incentives that would encourage estuarine and floodplain resource users to implement management practices that protect aquatic and riparian habitats.

5.6.1.1 Riparian and Floodplain Habitats

Objective:

To protect and restore the ecological diversity of locally indigenous floodplain and riparian plant communities and habitats.

<p><i>Explanation:</i></p> <p>Loss of riparian vegetation is one of the dominant characteristics of the Shoalhaven estuary, largely resulting from the agricultural value and practices on the adjacent floodplain. Loss of habitat (or poor recovery of habitat) is exacerbated at some locations by channel widening or migration. The intent of this objective is to encourage restoration of biodiversity regardless of land use or bank erosion status.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>No net loss in the area of Endangered Ecological Communities by 2016.</p> <p>Representative examples of Endangered Ecological Communities are included in some form of durable conservation management by 2016.</p> <p>A net reduction in the presence of invasive species in riparian and floodplain vegetation communities by 2016 (provide baseline data is available or can be established before 2008).</p> <p>Records of migratory wader populations are maintained and managers are aware of any significant trends in species, numbers or habitat used.</p> <p>The diversity of aquatic macroinvertebrates is maintained or enhanced by 2016 (see discussion of EII).</p>
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5.6.1.2 Aquatic Habitats

Objectives:

To enhance the area and quality of seagrass habitat in the estuary.

To maintain the area of salt marsh community in the lower estuary.

To restore freshwater wetland habitat on the floodplain.

To maintain and restore reed beds which fringe the riparian zone and protect estuary banks from wave action.

To reduce barriers to fish passage on the floodplain.

<p><i>Explanation</i></p> <p>Both seagrass and saltmarsh are critical fishery habitat in the estuary. In the past, structures to control the extent of tidal processes on the coastal floodplain and to increase the area of arable land have reduced or degraded the area of aquatic habitat in floodplain wetlands.</p> <p>Reedbeds add to the diversity of riparian habitats, but also perform a morphodynamic function by assisting with the protection of unconsolidated banks from wave action (wind and boat waves).</p> <p>Mangroves are also very important fishery habitat, as well as being efficient colonisers of accreting shorelines. Individual mangroves, once established, are protected. However, the expansion of mangrove habitat needs to be considered in the context of losses of other habitats in the estuary.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>No net loss in the area and health of seagrass habitat by 2016 (NRC Resource Condition).</p> <p>The number and significance of impediments to fish passage, such as floodgates leading to floodplain wetlands, are reduced.</p> <p>The top 10 priority blockages (as identified by DPI) are removed by 2016.</p> <p>Locally diverse habitat, such as shaded deep pools adjacent to high banks, is maintained.</p> <p>The length of bank with established reed beds and/or mangrove communities increases.</p>
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5.6.1.3 Habitat Connectivity

Objective:

To protect and restore the connectivity of riparian and floodplain habitats.

<p><i>Explanation</i></p> <p>As noted in Section 5.5.1.1, much of the riparian vegetation along the Shoalhaven estuary has been fragmented or degraded. This objective complements the riparian and floodplain habitat objective by focusing on the importance of connecting corridors between remnants of habitat to maximise their value.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>Connective corridors are established between remnants of wetland and riparian habitat on the floodplain and in the riparian zone by 2016.</p> <p>The length of vegetated riparian corridor is increased by 2016.</p> <p>(Note that both of these outcomes will affect visual character of the estuary and coastal floodplain and may also affect floodplain productivity).</p>
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5.6.1.4 Water Quality for biodiversity

Objective:

To manage water quality variability within the range and rate of change that is suitable for protection of aquatic habitats in both the upper and lower estuary.

(see also water quality objectives in relation to productivity and recreational amenity)

<p><i>Explanation</i></p> <p>Estuarine water quality, particularly in the upper estuary, is very variable. Salinity, for instance, can vary from barely brackish to close to ocean concentration, depending on the balance between tidal processes and freshwater inflow.</p> <p>Some other water quality parameters are affected by urban and industrial discharges.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>No blooms of harmful algae occur in the estuary.</p> <p>There are no fish kills in the estuary attributable to poor water quality</p> <p>pH in all parts of the estuary is maintained within the range 6.5 to 8.5, other than in exceptional circumstances</p> <p>There is no evidence of accumulation of heavy metals in shellfish in the estuary.</p>
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5.6.1.5 Acid Sulfate Soil

Objectives:

To provide a consistent approach to the understanding and management of ASS across the Shoalhaven River, Crookhaven River and Broughton Creek coastal floodplains.

To integrate ASS management with other aspects of floodplain management including agricultural productivity and habitat restoration.

To minimise/prevent ASS discharge events that significantly affect estuary water quality.

<p><i>Explanation</i></p> <p>ASS in the Broughton Creek section of the Shoalhaven estuary floodplain have been recognised as an ASS hotspot and have been the subject of extensive research and management action over several years. Prior to remedial action, very low pH levels were recorded and fish kill incidents occurred.</p> <p>Investigation and management of ASS in the Crookhaven section of the floodplain is less advanced, but there is also less evidence of a significant issue.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>The pH of the Shoalhaven River tributary estuarine creeks or channels remains consistently in the range 6.5 to 8.5.</p> <p>No fish (or other aquatic species) kills attributable to acid runoff events.</p>
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5.7 OBJECTIVES FOR PRODUCTIVITY AND COMMUNITY ENJOYMENT

The objectives of this section relate to the social, cultural and economic values of the estuary, all aspects of the community's relationship with the estuarine landscape. They address public access to the waterway and its foreshore, floodplain agriculture, commercial and recreational fisheries, tourism, visual attractiveness, and cultural associations (Aboriginal and historical). Also included in this section are social values attached to community involvement in environmental improvement projects.

5.7.1 Estuary Based Recreation

5.7.1.1 Recreational Access and Opportunity

Objectives:

To maintain diverse foreshore and water based recreational opportunities for residents and visitors, in keeping with the natural character of the estuary and recognising the potential for conflict between user groups with different values or needs.

To protect the safety of water based recreational users.

To encourage tourism businesses that complement sustainable use of estuary natural resources.

<i>Explanation</i>	<i>Indicator of satisfactory outcome</i>
<p>The estuary is a major recreational asset for local people and is also a key element of the Shoalhaven tourism strategy. Recreational uses include swimming, kayaking, fishing (upper estuary and lower estuary, plus access to ocean fisheries), shellfishing, seafood restaurants, picnics, camping, walking (bush and waterfront), water skiing and wakeboarding.</p> <p>Different parts of the estuary are suited to different styles of recreational use, because of their physical, ecological and aesthetic character (including resilience to development impacts), as well as road and water accessibility.</p>	<p>Council receives positive feedback about the facilities available in icon parklands and recreational boating facilities associated with the estuary.</p> <p>Low to negligible level of complaints about incompatible uses, particularly in the upper estuary, but also adjacent to popular reserves in the lower estuary.</p> <p>No boating safety incidents associated with the use of boat ramps and public wharves/jetties.</p> <p>Public access to the foreshore is maintained at the local level.</p> <p>High level of use of urban foreshore parklands (e.g. Nowra gateway).</p>

5.7.1.2 Estuary Foreshore Recreation

Objectives:

To provide recreational opportunities on public land on the estuary foreshore that are consistent with community lifestyle aspirations and with key ecological values.

To maintain public access to the foreshore for recreational activities.

<i>Explanation</i>	<i>Indicators of satisfactory outcome</i>
<p>Residents and visitors appear to value relatively low key recreational opportunities along the Shoalhaven estuary, based around family picnics, camping and fishing.</p> <p>Recreational boating preferences include small non powered craft (upper estuary), vessels for moving from one fishing area to another, and higher powered ski/wake board boats in specific areas.</p> <p>A high level of accessibility of locations with scenic outlooks, boating and road services, availability of fresh estuary produce (fish and oysters) etc is a key outcome.</p> <p>However, facilities for intensive recreational uses must also take the protection of ecological values into account.</p>	<p>Community satisfaction with facilities for enjoyment of the waterway at key foreshore reserves, such as Greenwell Point, Greys Beach, The Grotto, Nowra foreshore, Bangalay Reserve, Orient Point, Shoalhaven Heads.</p> <p>Public land in the upper estuary is identified and is accessible to waterway users.</p>

5.7.2 Aquatic Primary Production

5.7.2.1 Water Quality

Objectives:

To maintain estuarine water quality within the range that is consistent with oyster production/harvesting (particularly in summer), recreational swimming and boating (also most important in summer).

To protect water quality that is consistent with healthy fishery habitat in all parts of the estuary.

To minimise the impacts of excessive nutrient or other pollutant loads on estuary health and productive activity by promoting reuse of industrial and municipal wastewater.

<i>Explanation</i>	<i>Indicator of satisfactory outcome</i>
<p>Water quality has major implications for all aspects of the productivity of the estuary – both in terms of habitat and economic activity.</p> <p>Biological pollutants lead to closures of oyster lease areas and can also close swimming areas.</p> <p>Poor water quality (biological and nutrient pollutants) also affects fishery habitat and the reputation of the estuary as a recreational fishing area. Poor water quality can also discourage tourists.</p> <p>Reuse of effluent in agricultural and other contexts reduces the need for other water extraction and reduces nutrient and biological pollutant load to the estuary.</p>	<p>No closures of oyster harvesting due to poor water quality (long term aim).</p> <p>No closures of the estuary for swimming or boating due to poor water quality.</p>

5.7.2.2 Productivity of Aquatic Primary Industries

Objectives:

To support an ecologically and economically viable oyster industry in the estuary.

To maintain fish stocks at a level that is consistent with ongoing access by Aboriginal, recreational and commercial fishers.

<p><i>Explanation</i></p> <p>An important value of the Shoalhaven River estuary and its floodplain is the provision of fresh produce (fish, shellfish, vegetables etc) for local residents and visitors. The Shoalhaven River estuary has supported a commercial fishery or more than 100 years, since adequate refrigeration made transport of catch to the Sydney markets feasible. Oyster growing has also been a feature of the lower Shoalhaven estuary since the nineteenth century. Fishery catch is valued at approximately \$500,000 annually. About 200,000 dozen oysters are produced annually in the Crookhaven and lower Shoalhaven. Approximately 500,000 recreational fishers are reported from the south coast annually, although actual numbers of recreational fishers living in or visiting the Shoalhaven LGA are not known. Fishing and shellfishing are important traditional and historical activities for the large Aboriginal population living in the Shoalhaven LGA.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>Positive trend in the area of healthy freshwater wetland habitat on the floodplain.</p> <p>Oyster and fishing industries are maintained in the estuary and can compete with the products of other estuaries in terms of quality.</p> <p>Fish catch per unit recreational effort does not decline.</p>
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5.7.2.3 Floodplain Agriculture

Objectives:

To maintain and enhance the productivity of floodplain agriculture whilst protecting or restoring the ecological values of the floodplain.

To promote an integrated approach to floodplain land use.

<p><i>Explanation</i></p> <p>The Shoalhaven estuary floodplain has been a productive agricultural landscape for more than 100 years and has a history of dairying, pasture growth and vegetable growing, as well as more recent specialist horticulture.</p> <p>The availability of quality local horticultural produce is an important value in the community.</p> <p>Floodplain agriculture has been assisted in the past by a network of floodplain drains, lowering the water table and accelerating the drainage of floodwaters from productive areas. A side effect of this drainage has been the exposure of ASS and loss/degradation of floodplain wetland habitats. Much of the riparian vegetation has also been removed by clearing and cultivation/pasture growth up to the river bank, as well as allowing cattle access down the banks to the river.</p> <p>This objective recognises the importance of floodplain agriculture to the local economy and landscape, but also acknowledges the benefits of improved habitat.</p> <p>Improved floodplain management would also benefit the water quality of the estuary, in terms of nutrients, local fine sediment loads and bacteria.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>The value of floodplain production is maintained or enhanced, either with existing industries or new agricultural/horticultural land uses.</p> <p>Wetland habitat in specified wetland areas is restored (improved cover, diversity etc);</p> <p>Acid sulfate soil management techniques facilitate the return of some tidal incursion.</p> <p>The length of bank with healthy riparian vegetation communities is increased.</p>
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5.7.2.4 Economic Viability of Industries that depend on Estuary Condition

Objectives:

To maintain the presence of viable commercial fishing and oystering activities in the estuary.

To maintain and enhance the contribution of estuary based activities to employment and economic value in the tourism industry.

<p><i>Explanation</i></p> <p>Oyster growers in the estuary have noted the high costs of water quality and meat testing to demonstrate the compliance of their product with Clean Foods standards. Under the Oyster QAP, oyster growers carry the cost of most monitoring of biological health, including algae, viruses and bacteria as well as physical water quality parameters.</p> <p>Costs of monitoring increase when there are multiple pollution incidents.</p> <p>Poor estuary health (e.g. low pH) also affects the productivity of the estuary and therefore the economic viability of commercial fishing and oystering operations. Consequent reduced fish stocks also affect the appeal of the estuary for recreational fishing by visitors, detracting from tourism income.</p>	<p><i>Indicator of satisfactory outcome</i></p> <p>Maintenance activities, such as to sewage systems that may cause pollution incidents are planned to minimise discharges and impacts on estuary primary production and appropriate warnings are issued about such maintenance activity.</p> <p>The costs of water quality monitoring to demonstrate compliance with standards for safe primary contact and consumption of uncooked sea food are shared between polluters and beneficiaries.</p> <p>The pH of the Shoalhaven River estuary and its estuarine tributaries is maintained within the range 6.5 to 8.5, in accordance with water quality objectives.</p>
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5.7.3 Social and Cultural Values

5.7.3.1 Visual Quality

Objectives:

To maintain the visibility of the estuary from public land.

To protect outlooks and view sheds of high visual quality throughout the estuary.

<p><i>Explanation</i></p> <p>The Shoalhaven estuary comprises three major visual areas – the upper estuary/gorge, the lower estuary and the entrance areas. There are outstanding views across all three landscapes from public land and from the water. These views are important to both local residents and visitors.</p>	<p><i>Indicators of satisfactory outcome</i></p> <p>Community feedback (including visitors) about visual quality of the estuary and adjacent landscapes, in all three sections of the estuary.</p> <p>It would be possible to document changes in the visual character of selected locations by taking photographs from fixed points at regular intervals over time (e.g. annually).</p>
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5.7.3.2 Respect for cultural heritage

Objectives:

To respect the values of the Indigenous community of the Shoalhaven area, in management of the estuary and coastal floodplain.

To protect sensitive Indigenous Cultural Landscapes.

To provide opportunities for local Indigenous people to participate in the management of the estuary.

To protect important historical or artistic vistas along the estuary, such as those from Bundanon.

<i>Explanation</i>	<i>Indicator of satisfactory outcome</i>
<p>A large Aboriginal population lives around the Shoalhaven River Estuary and the Indigenous cultural heritage values of the estuary include archaeological sites, mission sites, places identified in community stories, places (and activities) with historical associations.</p> <p>In addition to its important Aboriginal heritage values, the Shoalhaven also has historic cultural heritage significance, primarily at the local landscape level. Bundanon is listed in the Australian Heritage Database (register of the National Estate) as “the most characteristic and important house to survive in the Shoalhaven region... Significant Australian artists have visited and painted the landscape.”</p> <p>Nowra Road Bridge is also listed in the Register of the National Estate.</p>	<p>These objectives will be achieved if the recommendations of the Shoalhaven Aboriginal Cultural Heritage Management Plan (in preparation) are incorporated into estuary management practices.</p> <p>Local Aboriginal community representative(s) participate in the Shoalhaven River Natural Resources and Floodplain Management Committee and/or provide input to the implementation of the Estuary Management Plan.</p> <p>Sensitive Indigenous Cultural Landscapes are afforded protection under the Estuary Management Plan.</p> <p>An Indigenous aquaculture strategy is developed and feasibility studies completed if the Shoalhaven River estuary is an appropriate site for this project (see Catchment Action Plan/Investment Strategy) Note that multiple other estuaries may be suitable for the Indigenous Aquaculture project.</p> <p>Significant landscape features and vistas are protected.</p>

5.7.3.3 Awareness and Inclusion

Note that community awareness of estuary management actions and inclusive opportunities to contribute to estuary management processes are also a component of integrated and co-operative management (**Section 5.3.1.5**).

Objectives:

To provide opportunities for the local community to be aware of estuary and floodplain management issues.

To provide opportunities for the local community to contribute to decisions about the future management of valued natural resources in the Shoalhaven estuary.

To provide ongoing opportunities for community engagement in implementing estuary management actions.

<i>Explanation</i>	<i>Indicator of satisfactory outcome</i>
As discussed in Section 4.7 , residents and visitors to the Shoalhaven value highly its natural and cultural landscape and the opportunities for water based recreation, and quality local produce that the estuary and coastal floodplain provide. Successful implementation of many of the proposed management actions for a sustainable estuary depends on community engagement and willingness to act.	The adopted estuary management plan includes clear reference to community comments and how they have been addressed in decision making. Positions on the SNRFMC for relevant community interests are filled and representatives are able to attend the majority of meetings. Community representatives on the SRNRFMC effectively disseminate information and represent the community's interests and concerns. Information about upcoming significant management actions and about the success of estuary management initiatives is reported regularly in local media and Council's Annual Report.

5.7.3.4 Support for Community Projects

Objectives:

To support community engagement in estuary management by providing financial or other support for projects that contribute to the protection of key estuary values.

To provide incentives for community individuals/groups to take up sound management of floodplain and estuary property.

<i>Explanation</i>	<i>Indicator of satisfactory outcome</i>
The environmental quality of the estuary benefits from the involvement of local community groups in assessment and management tasks. These community projects often draw in funding from sources outside the LGA which can be supplemented by Council support. The SRCMA is the primary agency responsible for supporting community groups and landholders to carry out natural resource management activities, both with technical advice and with funding support.	Community based projects are included in the Estuary Management Plan and continue to receive funding or management/administrative support from Council. This can include both "environmental" projects and projects for economic sustainability.

5.8 SUMMARY OF ESTUARY MANAGEMENT OBJECTIVES

Figure 5.1 summarises the objectives for achieving sustainability in the Shoalhaven River estuary.

5.9 ARE SOME OBJECTIVES MORE IMPORTANT THAN OTHERS?

For the estuary as a whole, all the objectives are relevant and important. However, some objectives will be more important for different parts of the estuary, depending on the current condition of each part (management zones as identified in **Section 2.5.3**). **Section 2.5.4** discusses a Principal Management Orientation for each of the management zones. When Principal Management Orientation and objectives are considered together, it is clear that certain objectives will take precedence in different zones. Some objectives (primarily about

integrated management, good communication and community participation) are relevant to all zones.

Table 5.1 shows the relationship between Principal Management Orientation and management objectives. The objectives that take precedence in zones for Comprehensive Protection focus on the protection or restoration of natural estuarine processes and habitats. For Significant Protection, these processes and habitats are also important, but social and economic objectives linked to naturalness are also important. For Healthy Modified management orientation, most objectives reflect the long term social and economic value of that part of the estuary. This does not mean that opportunities to enhance ecological values should be ignored. It does mean that habitat and process management must co-exist with productive enterprises. Targeted Repair Management Orientation is not considered to be appropriate for any management zone of the Shoalhaven River estuary.

Table 5.1: Important Management Objectives

Principal Management Orientation	Key Objectives
Comprehensive protection	<ul style="list-style-type: none"> • To respond to ongoing channel migration in accordance with risks to ecological and amenity values (rather than productivity). • To control activities that drive bed and bank erosion outside the anticipated impact of natural flow variability. • To maintain rates of sediment transport and localised in-channel erosion/deposition within the range anticipated with natural flow variability. • To maintain the range and pattern of freshwater flows into the estuary within natural variability. • To focus conservation efforts on buffers around vulnerable habitats where terrain would facilitate habitat migration in response to sea level rise. • To focus conservation efforts on vulnerable habitats that are unlikely to be lost due to sea level rise (this requires that other impacts on sustainability are controlled). • To enhance the area and quality of seagrass habitat in the estuary. • To maintain the area of salt marsh community in the lower estuary. • To maintain or enhance the area and health of mangrove habitat in the estuary, particularly where its presence benefits adjacent aquatic or terrestrial habitat. • To restore freshwater wetland habitat on the floodplain. • To maintain and restore reed beds which fringe the riparian zone and protect estuary banks from wave action. • To reduce barriers to fish passage on the floodplain, consistent with integrated management of ASS, agriculture and fishery habitat. • To protect and restore the ecological diversity of locally indigenous floodplain and riparian plant communities and habitats. • To manage water quality variability within the range and rate of change that is suitable for protection of aquatic habitats in both the upper and lower estuary. • To minimise/prevent ASS discharge events that significantly affect estuary water quality.

Table 5.1 - Important Management Objectives (cont)

Principal Management Orientation	Key Objectives
Comprehensive protection (cont)	<ul style="list-style-type: none"> • To protect water quality that is consistent with healthy fishery habitat in all parts of the estuary. • To protect sensitive Indigenous Cultural Landscapes.
Significant protection	<ul style="list-style-type: none"> • To maintain diverse foreshore and water based recreational opportunities for residents and visitors, in keeping with the natural character of the estuary and recognising the potential for conflict between user groups with different values or needs. • To protect the safety of water based recreational users. • To encourage tourism businesses that complement sustainable use of estuary natural resources. • To maintain the visibility of the estuary from public land. • To protect outlooks and view sheds of high visual quality throughout the estuary. • To maintain minimal intervention in entrance processes (Shoalhaven Heads) • To provide a consistent approach to ASS across the Shoalhaven River, Crookhaven River and Broughton Creek coastal floodplains. • To integrate ASS management with other aspects of floodplain management including agricultural productivity and habitat restoration. • To maintain and enhance the productivity of floodplain agriculture, at the same time as the ecological values of the floodplain are protected or restored.
Healthy modified	<ul style="list-style-type: none"> • To maintain estuarine water quality within the range that is consistent with oyster production/harvesting (particularly in summer), recreational swimming and boating (also most important in summer). • To minimise the impacts of excessive nutrient or other pollutant loads on estuary health and productive activity by promoting reuse of industrial and municipal wastewater. • To maintain the presence of viable commercial fishing and oystering activities in the estuary. • To maintain and enhance the contribution of estuary based activities to employment and economic value in the tourism industry. • To support an ecologically and economically viable oyster industry in the estuary. • To maintain fish stocks at a level that is consistent with ongoing access by Aboriginal, recreational and commercial fishers. • To promote an integrated approach to floodplain land use. • To protect the safety of water based recreational users. • To encourage tourism businesses that complement sustainable use of estuary natural resources.

6.0 DECISION MAKING PROCESSES

6.1 WHICH THREATS PRESENT SIGNIFICANT RISKS TO ESTUARY SUSTAINABILITY?

The concept of risk combines the likelihood of a threat occurring with the consequence of that threat. In the case of estuary management issues, the consequence is determined by the significance of the values that would be degraded or lost. AS/NZS 2004 defines the basic elements of a risk management assessment (see **Section 6.1.1**). However, there is relatively limited experience to date of the application of risk management approaches as a component of environmental management in the coastal zone.

Given the diversity of values that are included in the objectives of the NSW Coastal Policy, any risk assessment process needs to consider the nature of risks and opportunities for mitigation in relation to not only the built environment (including community infrastructure), but also to natural, social and cultural values. The risks that should be evaluated are, in effect, risks to ecologically and socially sustainable management of the coastal zone. The risks need to be considered in a long time frame, given the underlying principle of intergenerational equity.

A preliminary assessment of the significance of various estuary management issues in the Shoalhaven River estuary was presented in the Data Compilation Study (Umwelt 2005).

This preliminary assessment used a simple scoring system with three levels of likelihood and three levels of impact (against four risk criteria), and added scores for each of the criteria. Issues which accumulated the highest scores were considered to have the highest level of risk. The preliminary assessment concluded that four issues presented high or significant risks to the sustainable health of the estuary. There was general concurrence in the SFNRMC that these critical issues and a further group of seven issues (all with moderately high risk scores) represented the most important issues for the estuary.

The four highest risk issues were considered to be:

- Terrestrial ecology of the floodplain and floodplain wetlands. This issue takes into account the number of EECs present on the floodplain of the Shoalhaven River estuary, the previous long term degradation of those communities and habitats, and the contribution that healthy floodplain habitats can make to healthy and productive estuarine waters.
- Loss of vegetation communities and habitat in the riparian corridor. This issue encompasses loss of EECs on the river bank, loss of reed beds in the river and loss of habitat continuity, particularly in the lower estuary, where the floodplain margin to the waterway is continuous.
- Ongoing severe bank erosion, particularly downstream of Nowra.
- Aboriginal cultural heritage management – understanding, conservation, and engagement. Management of European (non Indigenous) heritage values was considered to be a less important issue.

The first three of these issues are clearly all related, and any response would need to present an integrated approach to sedimentary processes, drainage, floodplain land use and biodiversity conservation.

A further seven issues were considered to also present important risks:

1. Aspects of floodplain management and flood mitigation, particularly acid sulfate soil management, and its links to floodplain and estuary water quality and habitat loss.
2. Bank erosion along the margins of floodplain pockets in the upper estuary.
3. Connectivity of areas of high habitat value.
4. Environmental flow management in the upper estuary. The significance of this issue at the time was partly influenced by community concern, in the absence of detailed information from Sydney Catchment Authority. This situation has now improved.
5. Long term impacts of sea level rise on the marinisation of the estuary, the migration of aquatic habitats and the long term balance of habitat types in the estuary (e.g. mangrove and saltmarsh habitat).
6. The management of recreational activity in the upper estuary (note that recreational boating management in the lower estuary was considered to be a less important issue).
7. Interaction of local and regional/state level strategic planning for urban development and sustainable use of natural resources. This is primarily an issue about capacity for co-ordination.

To assist with decision making about appropriate management options and the priority of actions, a further systematic assessment of the risks affecting the values of the estuary has been conducted. Importantly, this assessment also considers the extent to which various potential management responses can reduce risks to the aspects of the estuarine environment that are highly valued by the community.

This qualitative assessment is broadly in compliance with the process described in the Australian and New Zealand Standard for Risk Management (2004). It applies the same concepts and follows the process outlined in the guideline accompanying the Standard. Key concepts and terminology, and how they have been applied to the Shoalhaven River estuary, are described below.

It is acknowledged that the risk assessment process can appear time consuming and cumbersome. Its value lies in four important attributes:

1. It provides a systematic process for thinking about estuary management issues and potential responses, so that important aspects are not overlooked. This also makes decision making more transparent.
2. It offers a process to question assumptions about which issues and actions will comprise good management.
3. It acknowledges the inherent uncertainty about some natural processes and that uncertainty may vary according to the time scale being considered.
4. It allows community values and information to be considered alongside scientific information, and can directly incorporate community values by using the local natural resource management committee as an "expert panel" to conduct and review the assessment process.

6.1.1 The Terminology of Risk Assessment

This section introduces the terminology used in risk assessments, based on AS/NZS 2004 and explains how the various terms have been used or interpreted in the current project.

Objectives

The objectives of the risk assessment are the same as the objectives of the Estuary Management Plan, as established in **Section 5**. These objectives relate to the protection or restoration/enhancement of estuary values.

Hazards or Threats

These are the processes that could affect the maintenance of estuary values. For the Shoalhaven River estuary, these include, but are not restricted to:

- sea level rise associated with climate change;
- other aspects of climate change, such as an increase in the number of intense rainfall events or more prolonged drought periods;
- ongoing system wide and local channel adjustments and channel change, for instance continuing changes to tidal flow patterns and current strength through Berrys Canal, or significant changes to channel form during major flood events;
- water extraction from the catchment, affecting the pattern of flows into the upper estuary;
- ongoing adjustments to existing structures and entrance controls in the estuary;
- ongoing floodplain drainage activities and flood mitigation activities;
- ongoing floodplain agriculture, including management of cattle and other activities in riparian and wetland vegetation communities;
- an increasing incidence of intensive recreational use of the waterway, such as increasing numbers of users of high power boats and wake boards;
- increases in visitor numbers and the number of permanent residents; and
- inappropriate or inadequate communication and management co-ordination.

Environmental aspects or responses (in this case, sustainability aspects)

Environmental aspects are the ways in which the estuary system may respond to the various threats. For instance, sea level rise may lead to higher water levels in the estuary, or to changes in current patterns.

Consequences (what will be lost or gained)

The environmental or sustainability consequences are the ways in which the various estuary values are affected by each threat. Each threatening process will have its own suite of consequences, although some consequences may increase as a cumulative effect of multiple threats.

As an example, possible consequences of sea level rise include:

- the area of saltmarsh habitat in the estuary may decline;
- salinity in the upper estuary may increase (or periods of higher salinity may become longer), impacting on habitat conditions for valued fishery species such as bass;
- the height, intensity and location of wave and current impacts on unconsolidated estuary banks may increase, exacerbating bank erosion;
- shoals used as migratory wader habitat may be permanently inundated, reducing their suitability for these species;
- flooding of low lying areas (including urban areas) may increase, for instance, due to a higher base level for storm surges;
- changes to the location and extent of in-channel bars and shoals affect the safety of navigation; or
- the apparent long term migration of the main channel is exacerbated, so that additional habitat or infrastructure is impacted.

For qualitative assessments of risk, impact or consequence may be described using the terms set out in **Table 6.1** (following Table 4(B) of Australian Standard 2005).

Table 6.1 - Extent of Impact or Consequence

Level	Descriptor	What does this mean - examples
1	Catastrophic	Major realignment of channel, with associated major financial losses to the community or Council. An impact that seriously affects the whole aquatic and/or terrestrial system of the estuary. Major change to community sense of identity or sense of place. Major community alarm or outrage, with national media coverage. Significant impact on public health (multiple people severely affected).
2	Major	Loss (removal or destruction) of critical habitat for important threatened species/protected species; severe damage to major recreational facilities or community infrastructure; significant contamination of estuary (requiring major clean up), loss of viability of major regional industry, etc. An impact that affects several reaches of the estuary.
3	Moderate	An impact that affects only one or two reaches of the estuary; changes from which recovery is possible with careful management, changes that result in low to moderate losses of floodplain or estuary productivity.
4	Minor	Localised or restricted impact, limited effect on livelihoods or local visual or recreational amenity, or biodiversity. Moderate financial losses.
5	Insignificant	Localised (affects only a few people) or barely detectable impact (i.e. could be within known natural variability), with low financial implications

Probability/likelihood

This refers to how likely an event is to occur (or how frequently it is expected to occur). The probability of some events can be stated as a recurrence interval (such as an average

recurrence interval 1 in 50 year storm or average recurrence interval 1 in 100 year storm); however, the frequency of other events cannot be predicted precisely and can only be described as low, medium or high probability. The risk assessment needs to take these differing levels of certainty into account.

Application of the Precautionary Principle (one of the four key principles of ecologically sustainable development) requires that actions should be taken to reduce significant risk, even where there is a lack of scientific information to quantitatively define the risk (for instance, uncertainty about the probability of an event). Delay whilst indisputable data is collected cannot be justified where there is strong qualitative evidence of a significant risk that can be reduced.

The assessment of risks to a sustainably healthy Shoalhaven River estuary is based on qualitative measures of likelihood, in accordance with the Australian Standard. **Table 6.2** (following Table 4(A) of Australian Standards 2005) describes the various levels of probability that have been applied.

Table 6.2 - Likelihood

Level	Likelihood	Description/qualification
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Could occur
D	Unlikely	Could occur but not expected
E	Rare	Only occurs in very exceptional circumstances

Risk

According to the Australian Standard, risk is a combination of likelihood and consequence. Risk may have both positive and negative impacts on a value, and is an indication of the scale or magnitude of a change that may occur.

Depending on the various combinations of likelihood and consequence, risks may be considered to be extreme (e.g. an almost certain impact that is catastrophic or major in scale), high, moderate or low (an impact that is rare and is very limited in scale).

Risk Assessment Criteria (how acceptable is the risk?)

Some risks will be considered either acceptable in their own right or a reasonable trade off for achieving other preferred outcomes. Risk assessment criteria are used to help decide which risks are acceptable. Application of agreed risk criteria helps to decide which risks need treatment and the priority of risk reduction actions. In the context of estuary management, an assessment of the relative levels of risks to different values can, for instance, help with decisions about whether bank erosion should be treated. The risk evaluation can also guide decisions about whether treatment of bank erosion should be done before or after other actions, such as provision of new recreational facilities or restoration of floodplain habitat.

The Australian Standard (2005) describes three categories of risks in terms of acceptability:

- Acceptable risks – the community considers that these risks are low, and they are prepared to live with any consequences that may emerge. No further consideration or reduction of these risks is considered necessary.

- Risks that are considered to be unacceptable in any circumstances. These risks are considered to be intolerable and in general, communities demand urgent action to reduce the risk. In estuary management contexts, such a risk could be associated with bank erosion that was considered certain to destroy major community infrastructure (such as a regional sewage treatment plant), causing other environmental impacts from uncontrolled discharges of toxic substances.
- Risks that are considered to be tolerable, but which are not acceptable. This middle group may generally include risks that are assessed anywhere from moderate to extreme, but the level of acceptability depends on costs, technical capability and other tradeoffs. Over time, community attitudes to this group may change sufficiently to change their priority for action, so regular monitoring of attitudes, information and cost/benefit should be conducted. For this current assessment, community views about the acceptability of risks have been based on conversations and meetings with the SFNRMC and other local land and waterway users. Much of the discussion of options in **Sections 7 to 10** of this Estuary Management Plan focuses on the tolerable but not acceptable risks.

Risk Management Options (Estuary Management Options)

Estuary management options are ways to manage risk. They will vary from “business as usual” to major intervention works, and include education, land use planning, land acquisition, floodgate management, construction of major bank protection or flow training structures etc (see **Sections 7 to 11**).

Risk Evaluation of Options (Do they reduce risk, and in what ways?)

The final component of risk assessment is consideration of the extent to which various management options reduce important risks. How much risk will remain after the suggested activity or measure has been implemented? This is useful information for assessing the cost/benefit of actions. It may become apparent, for instance, that a high cost action is likely to have only limited impact on the risk, even if it seems, on the face of it, to be an obvious response.

6.2 RISK ASSESSMENT

Sections 6.2.1 to 6.2.7 discuss the risks associated with major threats to the sustainability of values of the Shoalhaven River estuary. The major threats are derived from the discussion in **Sections 4.1.1** (biodiversity), **4.2.1** (visual quality of the landscape processes), **4.3.1** (bank erosion), **4.4.1** (Aboriginal heritage), **4.5.1** (historic heritage), **4.6.1** (community lifestyles and recreation), **4.7.1** (tourism and visitor recreation), **4.8.1** (primary production – terrestrial and aquatic), **4.9.1** (regional growth) and **4.10** (climate change). Major threatening processes identified in the Shoalhaven River Estuary Data Compilation Study (Umwelt 2005) are also taken into account.

Because climate change has the potential to effect virtually all aspects of estuary processes, condition and usage, the risks associated with components of climate change (sea level change and other aspects such as drought and storminess) have been considered carefully. Risks associated with climate change issues are discussed in **Sections 6.2.1 and 6.2.2**.

Table 6.3 shows how the various threatening processes relate to the four major management themes for the Estuary Management Plan. Note that a separate full risk assessment has not been conducted in relation to management integration. The Healthy Rivers Commission (HRC 1999) has previously addressed the threats that poor integration of natural resource management programs present to efficient and sustainable management (see Umwelt 2005

and **Section 2** of this document). The HRC has stressed particularly the importance of clear and consistent signals to land and waterway users by all policy and regulatory authorities, with coastal floodplain management identified as an example of a high risk location if these consistent messages are not provided.

Table 6.3: Threatening processes and management themes

Management theme	Summary of threats and risks considered
Management integration and co-operation Section 7.1	Communication and co-ordination issues; resourcing of Council and agencies for meetings, co-ordination and provision of technical advice; monitoring and information sharing; transparent processes for evaluating management options.
Morphodynamic processes Section 6.2.3 and 6.2.4	Ongoing bank erosion and channel migration affecting all aspects of bank management and use (recreational, loss of fences, pump sites, etc.); management of catchment flows (water extraction) affecting flood levels and sedimentation patterns in the estuary; entrance management affects water quality and channel stability; tidal ventilation of floodplain channels and wetland; process changes associated with sea level rise and other aspects of climate change; some existing urban and industrial land is flood prone.
Biodiversity Section 6.2.5	Management of floodplain drainage systems in relation to wetland habitat, fish passage and water quality impacts; impacts of weed invasion and feral animals; agricultural land use impacts on habitat continuity, impacts of sea level rise on habitat for migratory waders, distribution of saltmarsh and wetlands, salinisation of upper estuary and success of rehabilitation programs; impacts of water extraction (fresh water flows) on wetland water levels.
Productivity and community enjoyment Section 6.2.6, 6.2.7 and 6.2.8	Piecemeal management of both Aboriginal and historic heritage values; management of foreshore recreation areas and water based recreation (boating, fishing etc.); impacts of power boating activities on bank stability; long term productivity and equity of access to commercial and recreational fisheries; sustainable aquaculture; effects of agricultural drains on wetland habitat; urban growth and tourism – suitable land, infrastructure capacity implications for natural resources; effects of oxidation of acid sulfate soils around agricultural drains; impacts of sea level rise and other aspects of climate change on flooding and navigation safety; impacts of stormwater and wastewater discharges on estuary uses; high costs of flood mitigation and bank erosion control structures relative to benefit; uncontrolled vehicle access to floodplain wetlands and EECs; crowding of waterway access facilities (ramps, foreshore parks etc.) creates safety and amenity issues.

6.2.1 Sea Level Rise

Table 1 of **Appendix 1** summarises potential aspects and impacts of sea level rise contributing to risks to the values of the estuary. Information about the extent of sea level rise is presented in **Section 4.10**, drawing on the most recent CSIRO (2006), Australian Greenhouse Office (2003) and IPCC (2001) reports.

There is considerable uncertainty associated with both the likelihood of these potential impacts and their severity, both within the Shoalhaven River estuary and in terms of conservation of key values at a regional scale. All estuarine waterways will be affected by sea level change to some extent, but the degree of impact is expected to be variable. There is general scientific consensus that major channel change processes are already occurring in the Shoalhaven River estuary, not driven by sea level rise, and there have also been strong views expressed that intervention in sedimentary (morphological) processes may cause unexpected

consequences. Insufficient information is currently available to quantify potential impacts. Responses therefore need to be precautionary and cautious.

Nearly all aspects of sea level rise are assessed as presenting high or extreme risks to one of more estuary values. The highest risks are considered to be associated with potential losses of saltmarsh habitat in the lower estuary and acceleration or exacerbation of bank erosion and channel change. These bank instability risks will affect sensitive riparian habitat, community facilities, agricultural land and infrastructure.

Whilst some of these risks may be considered to be tolerable by the community, the extreme risk is unlikely to be acceptable. **Table 1** in **Appendix 1** identifies strategies to reduce risks associated with sea level rise and these are further discussed in **Section 8.1**.

6.2.2 Other aspects of Climate Change – Drought and Storms

Table 2 of **Appendix 1** summarises aspects of the impacts of other components of climate change, such as extended drought and higher intensity rainfall events, on the values of the Shoalhaven River estuary. The table draws on broad scale information about potential changes to a range of climate conditions, as discussed in **Section 4.10**.

The risk assessment identifies potentially severe impacts on the viability of the oyster industry in the estuary, both from more extreme flood events and extended hot periods. Extreme risks are also identified for floodplain agriculture and infrastructure if high ARI storms are superimposed on a higher sea level. SCC is investigating this issue further in its Floodplain Management Plan.

Although there is a high level of uncertainty about exactly how process changes will occur and over what timeframes, the destabilising effect of aspects of climate change is considered to present high to extreme risks to agriculture (e.g. increased flood severity or more prolonged drought, to channel stability, and to the success of riparian revegetation programs. Increased salinisation of the upper estuary would also be a high risk resulting from prolonged drought periods (in addition to the effects of sea level rise).

Measures to reduce these and other high risks associated with aspects of climate change are discussed in **Section 8.2**.

6.2.3 Ongoing bank erosion and channel adjustment

Table 3 of **Appendix 1** presents an assessment of the risks that ongoing bank erosion and channel adjustments present to the health of the estuary. Some of these risks result from direct threats to ecological or infrastructure values; some result from loss of productive agricultural land; some result from impacts on the scenic value of the estuary (vegetated banks as opposed to high bare banks); and some result from the indirect effect that bank erosion may have on habitat restoration programs (be reducing the success of replanted vegetation).

The loss of important aquatic and riparian habitat at Comerong Island, due to ongoing adjustments to the size of the channel is considered to be by far the highest risk associated with ongoing erosion. The detrimental effect of bank erosion on habitat restoration and habitat continuity is also considered to be a high risk for the Shoalhaven estuary. Other risks are considered to be generally low at a system scale. This is because they are localised, or represent only a small percentage of the available land for a given use, or the consequences are considered to be minor. However, ongoing bank erosion is also considered to be unacceptable where it affects high profile (heavily used by locals and visitors) recreational sites, even though the overall risk is relatively minor.

6.2.4 Water extraction from the Catchment

Table 4 of **Appendix 1** summarises aspects of the potential impacts and risks of water extraction on estuary values. Further information about existing water management policies and programs is included in Umwelt 2005. Management actions currently under consideration by Sydney Catchment Authority are discussed in **Section 8.1 (Table 8.2)**.

Overall, the risks to estuary values associated with future management of environmental flows into the upper estuary are considered to be low and acceptable. Proposed flow management options (see SCA August 2006) will mimic the natural flow variability of the upper estuary more closely than does the current environmental flow rule for Tallowa Dam. Low flows will be better protected than now. Very high flows will not be affected. Boyes (May 2006) and SCA (August 2006) report than further investigations of the relationship between flow and salinity in the upper estuary are continuing. The results of these studies will help to refine understanding of the most appropriate environmental flow regime for the estuary.

6.2.5 Ongoing adjustments to Existing Structures and Entrance Controls in the Estuary

Table 5 of **Appendix 1** summarises the risks to estuary values that are associated with the management of the two entrances of the Shoalhaven River estuary (Shoalhaven Heads and Crookhaven Heads). Also considered in **Table 5** of **Appendix 1** are existing major bank protection works (rock walls).

The risk assessment acknowledges the ongoing channel adjustments, in train since the excavation of Berrys Canal and the construction of the Crookhaven Heads training wall. Severe erosion is expected to continue. Other entrance management issues are considered to present only moderate risks.

6.2.6 Ongoing Floodplain Drainage Activities and Flood Mitigation Activities

Table 6 of **Appendix 1** summarises the risks associated with floodplain management activities and land uses, including drainage, grazing, land clearing, flood mitigation structures and other intensive agricultural pursuits.

Two aspects of floodplain management are considered to present extreme sustainability risks. Both relate to the relationship of floodplain drainage, clearing and other land management issues in riparian and floodplain habitats, including the habitat of the Green and Golden Bell Frog.

Other aspects of floodplain drainage management, including the presence and operation of floodgates, are associated with high risk aspects (fish passage and fish kills).

Measures to reduce these extreme and high risks are discussed in **Section 9**.

6.2.7 Increasingly intensive recreational use of the waterway

Table 7 of **Appendix 1** summarises aspects of the risks to sustainable estuary values, associated with recreational use of the waterway. Of particular interest are the risks associated with powered boating (ski boats and wake boards), potential conflicts between powered and non powered boating activities, and recreational fishing. These issues and possible threats are introduced in **Sections 4.6** and **4.7**.

Also assessed in **Table 7** of **Appendix 1** are risks associated with structures such as wharves, launching ramps and jetties that have been constructed to support recreational amenity.

The risk assessment, based on the views of members of the SRNRFMC, in the context of predicted increases in recreational boating demand and limited current data on boating usage, suggests that high risks are associated with existing and potential conflicts between passive and active waterway users, particularly in the upper estuary. “Waterway users” in this context includes people boating on the estuary in canoes, fishing boats, ski boats or towing wake boards. It also includes people picnicking on the banks and residents or visitors to waterfront properties. In this sense, waterway use takes into account lifestyle values as well as recreational values.

It is acknowledged that current recreational boating numbers on the Shoalhaven River estuary are relatively low (except for special events and particular holiday periods), and the number of reported incidents is also low. To some extent, the perception of negative interaction between passive users and active users of the waterway arises from the history of relatively low intensity waterway use, so that even a small change in noise levels or wave generation is seen to be significant by people on or around the river.

Significant risks are also considered to be associated with the safety and amenity of boat ramps and other foreshore facilities as visitor numbers, affluence and expectations increase over time. To some extent, the perceived conflicts on the upper estuary arise because of the limited number of launching facilities upstream of Nowra. This means that people wanting to access the upper estuary must cruise at speed from the main launching facilities, adding to traffic through reaches that they would otherwise not necessarily visit.

A decline in recreational amenity in turn affects the image of the region as a safe, relaxed and peaceful holiday or weekend destination.

The various risks associated with recreational boating are not considered to be acceptable.

6.2.8 Increases in visitor numbers and the number of permanent residents

Table 8 of **Appendix 1** summarises aspects of the risks associated with regional growth. These issues have been considered in the development of the South Coast Regional Strategy (see **Sections 4.6.1** and **4.9.1**). Specific potential risks to estuary values are discussed here.

The highest risks from further urban development around the Shoalhaven River estuary are associated with increasing demand on local water and sewerage infrastructure. Most important is the capacity of local wastewater management systems to treat all sewage to an acceptable level, and preferably the capacity to reuse effluent rather than discharge it to sensitive estuarine waters.

Other moderate to high risks include stormwater discharges from expanding urban areas (to the estuary or to floodplain wetlands) and the potential impacts on important Aboriginal cultural landscapes. Lower risks are associated with the side effects of urban development and increasing population. These include changing perceptions of how the estuary foreshore should be managed (e.g. wrack management and rock walling), changing views from the waterway or public view points (as villages expand), increased pressure on riparian vegetation (for view maintenance) and increased risk of rubbish dumping in reserve areas.

The general risk of increased permanent population on the lifestyle of existing residents has not been assessed specifically. A proper assessment would require significant community input, beyond the scope of the current project.

6.2.9 Aquatic Productivity

Table 9 of **Appendix 1** summarises aspects of risks associated with the ongoing management of commercial and recreational fishing and oystering industries.

These risks are associated with the impact of other land and waterway uses on the quality of oyster product. The water quality objectives and standards for areas where oysters are produced for human consumption require very clean water. This means that water quality impacts such as persistent sewage overflows present extreme risks and urban stormwater discharges to oyster lease areas are also a high risk.

There is some evidence (DECC Pers. Comm.) that elevated nutrient levels occur in the middle reaches of the estuary (i.e. downstream of Nowra and the Bomaderry industrial areas), and are associated with occasional algal blooms. Macroalgae interferes with estuarine fisheries both in terms of impacts on fish health and in terms on fouling of nets. Although industrial discharge quality has significantly improved in recent years, the potential for algal blooms associated with poor urban stormwater management remains, particularly if the predicted significant increases in the size (population and extent of development) of Nowra/Bomaderry occur.

The existing floodplain drainage system and floodgates around the Shoalhaven River estuary have impacted in fishery habitat and on water quality (through acid discharges). Although acid generation has been addressed through specialist management programs, habitat impacts remain a risk for healthy fish populations. In the medium term, this is considered to be a high risk, particularly when coupled with the habitat impacts associated with anticipated sea level rise and other aspects of climate change.

6.2.10 Summary of Risks to Estuary Sustainability

On the basis of the risk assessment presented in **Appendix 1** and summarised in **Sections 6.2.2** to **6.2.8**, the following issues are considered to be associated with the highest risk to the sustainability of the Shoalhaven River estuary and are likely to be unacceptable to the community (**Table 6.4**):

Table 6.4 – Summary of highest risks to estuary sustainability - Shoalhaven

Type of risk	Highest risk consequences
Risks associated with sea level rise and climate change.	<ul style="list-style-type: none"> Increased losses of saltmarsh habitat. Exacerbation of bank erosion. Exacerbation of channel migration. Threats to floodplain infrastructure and estuarine primary production due to increased incidence of high intensity floods.
Ongoing bank erosion and channel adjustment.	<ul style="list-style-type: none"> Ongoing bank erosion due to flexing/migration of the main channel and ongoing impacts of flood flows and wind waves – a critical limiting factor for restoration of riparian habitat.
Entrance management and major structures.	<ul style="list-style-type: none"> Ongoing bank erosion and channel widening associated with adjustment of the estuary to Berrys Canal and training walls at Crookhaven Heads.

Table 6.4 – Summary of highest risks to estuary sustainability – Shoalhaven (cont)

Type of risk	Highest risk consequences
Floodplain management.	<ul style="list-style-type: none"> Floodplain drainage will continue to reduce natural wetland habitat on the floodplain. Floodplain land use and flood management structures contribute to poor retention of terrestrial and riparian habitat in floodplain areas.
Increased recreational demand.	<ul style="list-style-type: none"> Conflicts between powered and non powered boat users (upper estuary), in terms of noise and safety (waves, collisions etc).
Increased permanent and visitor population.	<ul style="list-style-type: none"> Increased demand on local infrastructure – water supply, wastewater treatment and management, waste management etc.
Primary industries – floodplain and waterway.	<ul style="list-style-type: none"> Oyster and fishing industries are affected by invasion by weed species or other toxic marine pests or diseases that damage aquatic habitat or attack fish/oyster stock.

Table 6.5 summarises the high and medium to low risks for sustainable estuary health.

Table 6.5 - High and Low to Moderate Risks – Shoalhaven River Estuary

Risk type	High risk consequences	Low to moderate risk
Sea level rise and other aspects of climate change.	<ul style="list-style-type: none"> Changing salinity patterns in the upper estuary affects fishery habitat for valued species. Permanent inundation of shallow shoals used by migratory waders. Increased flooding of low lying areas. Changes to bars and shoals affect navigation safety. Reduce success of riparian vegetation improvement programs. Changes to floodplain aquifers affect agriculture and groundwater dependent ecosystems. Increased threat of mosquito transmitted diseases. Losses to oyster production due to more frequent high temperature events coupled with changes to tidal patterns. Changes to water biochemistry affect fishery habitat, favouring pest species such as nuisance algae. 	<ul style="list-style-type: none"> Possible loss of areas suitable for recreational navigation. Loss of agricultural land due to bank erosion. Degradation of near bank aquatic habitat due to bank erosion. Impacts of bank erosion on recreational amenity and safety.

Table 6.5 - High and Low to Moderate Risks – Shoalhaven River Estuary (cont)

Risk type	High risk consequences	Low to moderate risk
Ongoing bank erosion and channel adjustment.	<ul style="list-style-type: none"> • Reduced recreational amenity and/or safety where high profile foreshore reserves are affected by bank erosion or strong currents. 	<ul style="list-style-type: none"> • Shoals at Crookhaven Heads affect navigation safety. • Closure of Shoalhaven Heads causes minor flooding in the village area. • Closed entrance at Shoalhaven Heads affects water quality in nearby parts of lower estuary. • High cost of constructing and maintaining structural controls on bank erosion sites • Loss of small remnants of EECs on estuary bank (upper estuary) • Reduced stock access or loss of farm infrastructure due to bank erosion • Increased in-channel sedimentation (islands) • Erosion affects water quality • Changes to aquatic habitat adjacent to eroding banks.
Floodplain management.	<ul style="list-style-type: none"> • Low pH events cause fish kills and other impacts on aquatic ecology. • Remnant EECs or TS habitat are threatened by floodplain drainage, access and fire management regimes. • Floodplain drainage systems block fish passage. • Discharges/overflows from the sewerage system degrade biological water quality and affect oyster industry viability. • Limited understanding of full costs and benefits of floodplain agriculture and floodplain habitat. 	
Water extraction and environmental flow management.		<ul style="list-style-type: none"> • Modification of freshwater flows reduces small flushing events (moderate flows) in the upper estuary. • Modification of freshwater flows affects sediment supply and transport in the upper estuary.

Table 6.5 - High and Low to Moderate Risks – Shoalhaven River Estuary (cont)

Risk type	High risk consequences	Low to moderate risk
Entrance management and major structures.		<ul style="list-style-type: none"> • Shoals at Crookhaven Heads affect navigation safety. • Closure of Shoalhaven Heads causes minor flooding in the village area. • Closed entrance at Shoalhaven Heads affects water quality in nearby parts of lower estuary. • High cost of constructing and maintaining structural controls on bank erosion sites
Floodplain drainage, flood mitigation and floodplain use.	<ul style="list-style-type: none"> • Low pH events will continue to cause fish kills and other impacts on aquatic ecology. • Remnant EECs or TS habitat are threatened by floodplain drainage, access and fire management regimes. • Floodplain drainage systems block fish passage. • Discharges/overflows from the sewerage system degrade biological water quality and affect oyster industry viability. • Limited understanding of full costs and benefits of floodplain agriculture and floodplain habitat. 	<ul style="list-style-type: none"> • Parts of Terara, Bolong industrial area are flood prone. • High cost of maintaining flood protection structures
Increased recreational use	<ul style="list-style-type: none"> • Increased recreational demand on boat ramps affects safety and amenity (crowding, user skills etc). • Significant expenditure required to upgrade and extend inadequate foreshore facilities for recreational users. • Uncontrolled 4WD access degrades floodplain wetland habitats. • Increased impacts of boat waves on bank stability (mostly upper estuary). • Potential amenity and safety conflicts between passive and active recreational users. 	<ul style="list-style-type: none"> • Reduced regional image, due to anecdotal information about crowding and amenity. • Damage to riparian habitat from poorly managed camping activities. • Increased demand for recreational moorings over seagrass habitat areas in lower estuary. • Increased recreational fishing effort reduces fish stocks.

Table 6.5 - High and Low to Moderate Risks – Shoalhaven River Estuary (cont)

Risk type	High risk consequences	Low to moderate risk
Increased numbers of visitors and permanent residents	<ul style="list-style-type: none"> Increased impacts on cultural heritage places as urban areas expand and pressure on natural areas increases. 	<ul style="list-style-type: none"> Increased urban stormwater load on estuary water quality. Increased pressure on riparian vegetation due to view maintenance, clearing for new development etc. Increased demands on Council (time and cost) for wrack management and responses to pollution incidents. Illegal dumping and feral animals affect estuarine /floodplain habitats.
Aquatic primary industries	<ul style="list-style-type: none"> See also climate change issues. Fishery habitat is degraded by ASS discharges or other toxic biological pollutants. 	<ul style="list-style-type: none"> Commercial estuary fisheries lead to decline in stocks of major species. Recreational fishing creates litter that threatens bird health. Localised contamination of oyster leases due to poor site management.

6.2.11 Acceptable, Unacceptable and Tolerable Risks

Australian Standard HB 203:2004 discusses the acceptability of risks. The risk assessment tables in **Appendix 1** of this Plan provide an indication of whether risks to the values of the Shoalhaven River estuary are considered to be acceptable (no action necessary), unacceptable (require urgent action) or tolerable (action depends on other factors such as costs or available tradeoffs).

In the case of decisions about estuary management, determining whether a risk is acceptable, unacceptable or tolerable for any part of the estuary is influenced by the agreed Principal Management Orientation. Management orientations for each management zone of the Shoalhaven River estuary are discussed in **Section 2.5.4**.

- **Comprehensive Protection:** *Focus on protecting and enhancing naturalness and biodiversity values:* Unacceptable risks are most likely to be significant risks to these values.
- **Significant Protection:** *Naturalness and biodiversity values are still the most important, but the area also has important recreational or primary industry values:* Unacceptable risks may threaten both natural values and specific land uses.
- **Healthy Modified:** *Recognise the contribution of residential, commercial and recreational uses to the values of the area, linked to specific biodiversity values that support those uses.* Unacceptable risks are most likely to threaten this active development style landscape.

Note that the acceptability of risks is to some extent independent of the level of the risk. A local community may determine that an extreme risk is tolerable, because there is no cost

effective way to mitigate its effects and adaptive strategies will be adopted instead. Similarly, a moderate or low risk issue may be seen as unacceptable to local communities, although its overall impact on sustainability is limited.

For instance, the ongoing erosion of Berrys Canal is considered to present an extreme risk to high quality and high value estuarine habitat. However, successful structural measures to stabilise the banks present major engineering challenges and would be very costly to construct and maintain. In this case, the severe erosion may be considered to be tolerable, and alternative measures preferred. In contrast, safety risks at major recreational boat ramps and foreshore reserves may be considered to be unacceptable although the sustainability risk is lower.

As discussed in **Section 6.3**, the highest priority actions will be those that can produce significant mitigation of extreme risks that are also considered unacceptable in any circumstances by the community.

Table 6.6 summarises the acceptability of risks associated with various aspects of the Shoalhaven environment. The strategies and actions in **Sections 7 to 11** address risks that are unacceptable. These sections also address issues which may be tolerated, depending on other factors. These additional factors that affect decision making are discussed in **Section 6.3**.

Table 6.6 - Unacceptable and Tolerable Risks to Estuary Sustainability

Unacceptable risks	Tolerable risks	Commentary/explanation
<ul style="list-style-type: none"> • Loss of saltmarsh habitat. • Ongoing severe bank erosion, increased severity of bank erosion, and potential for major channel change. • Losses in the oyster industry due to increased heating/drying and storminess. • Floodplain drainage reduces natural terrestrial biodiversity and wetland habitat on the floodplain. • Uncontrolled recreational access to quality floodplain wetland habitat. • Conflicts between powered and non powered boat users (noise and safety) • Limitations to riparian habitat recovery/restoration due to bank erosion. • EECs and TS habitat on the floodplain reduced in area. • Loss of fish habitat in upper reaches of estuarine creeks without clear gains in floodplain productivity (or significant reductions in ASS generation). 	<ul style="list-style-type: none"> • Most aspects of sea level rise and climate change. • Training walls and Berrys Canal drive ongoing channel adjustment upstream (bank erosion, channel widening). • Shoals affect navigation safety. • Flooding of low lying village areas (Shoalhaven Heads). • Low pH events cause fish kills. • Ongoing channel migration and realignment. • Lack of knowledge and certainty about the risks and benefits of floodplain management. • High costs of flood protection structures – where they protect valuable residential real estate. • Loss of fish stocks due to increased recreational fishing activity. • Reduced safety and increased crowding on recreational boat ramps. 	<p>There are likely to be very high costs associated with actions to prevent landscape changes following climate change. Adaptation is more practical.</p> <p>Reduction in the area of isolated and small areas of EECs and TS habitat may be considered more acceptable than general loss of floodplain habitats/biodiversity because of small area and number of species involved – however, note that most floodplain and wetland communities are recognized as EECs because of cumulative impacts of coastal floodplain management in NSW.</p> <p>Ongoing bank erosion is a critical factor affecting the enhancement of riparian habitat.</p> <p>Lack of certainty or knowledge is noted for floodplain costs/benefits, but is also a major issue in relation to sea level change and other aspects of climate change.</p> <p>The HRC has previously noted the level of uncertainty and high costs associated with structural controls for erosion along the main Shoalhaven estuary channel and in Berrys Canal.</p>

Table 6.6 - Unacceptable and Tolerable Risks to Estuary Sustainability (cont)

Unacceptable risks	Tolerable risks	Commentary/explanation
<ul style="list-style-type: none"> • Impact of boat wakes on bank stability in reaches that would not otherwise be affected by erosion (generally upper estuary). • Impacts of development on significant cultural heritage places. • Increased urban stormwater impacts on estuary water quality (detract from recreational values). • Increased dumping and feral animals affect important habitat. • Poor performance (leaks, discharges or overflows) from wastewater treatment and transport infrastructure (threats to oyster industry). • Invasion by toxic or pest species (weed such as <i>Caulerpa</i>) could damage aquatic habitat and aquatic industry viability. • Contamination of oyster leases by poor local waste management (within the industry). • Poor safety or amenity of high profile foreshore reserves due to bank erosion. 	<ul style="list-style-type: none"> • Insufficient foreshore facilities (and moorings) to maintain safety and amenity for increasing user numbers. • Damage to riparian habitat due to poorly managed camping activities (on private land). • Riparian habitat damage due to view maintenance etc. • Temporary declines in stocks of fish targeted by commercial fisheries 	<p>Loss of fish stocks is not acceptable in the long term (biodiversity values) but may be tolerated in the short term.</p> <p>Similarly crowding of recreational boating access facilities may be tolerated in the short term, but is unacceptable in the longer term. Poor match of other foreshore facilities to demand is also unacceptable in the long term. All of these factors influence the regional image (see vision for estuary). A Boating Management Plan is in preparation to address these issues.</p>

6.3 EVALUATING OPTIONS

For any identified estuary management issue there will be multiple possible responses, ranging from “do nothing,” to new planning requirements, education, promotion of new ideas and attitudes, habitat rehabilitation, investment in new recreational facilities and visitor services, new legislation/regulation and construction of technically complex structures.

Options for the management of the key issues for the Shoalhaven River estuary are discussed in **Sections 7 to 10**. This section establishes how the opportunities offered by these options can be assessed, so that preferred approaches can be defined and justified.

Section 6.2 establishes the level of risk to estuary values of the Shoalhaven River estuary, deriving from a range of issues and processes. Understanding the level of risk and the extent to which risks to estuary values can be mitigated is a fundamental part of evaluating management actions and priorities. However, there are several other criteria that also need to be taken into consideration when evaluating potential management options. These are noted below. Whilst some of these criteria have also been considered in the risk assessment, it is worthwhile, for clarity, noting them separately.

Preferred options for managing the Shoalhaven River estuary will have the following characteristics, as noted in **Table 6.7**. It is apparent that many of these criteria for evaluating management options are qualitative and relative, rather than quantitative or absolute. Preferences and relative values may change over time, as more information becomes available or community attitudes to the environment respond to new “big picture” scenarios. This is one reason why adaptive management and regular review of management strategies is very important.

Table 6.7 - Characteristics of Preferred Management Options

Criteria	Application and indicators
<p>The management action will reduce risk to estuary values to the point where it is considered to be acceptable by the community and by scientific experts.</p>	<p>A qualitative risk assessment indicates that the option will produce a substantial reduction in risk, and preferably a greater reduction in risk than alternative options (note that the accuracy of qualitative risk assessment may not allow full consideration of relative risk reduction).</p> <p>An Expert Panel considers that risk associated with an important issue would be reduced to an acceptable level. The Estuary Management Committee (in this case SFNRMC) is considered to be an Expert Panel. Other Expert Panels may be established by the Department of Natural Resources or Department of Planning in relation to sustainability and development assessment.</p>
<p>The management action will contribute to the maintenance or enhancement of estuary values (i.e. not only controls risk but creates substantive benefits). The intent overall is to maintain the net value of the estuary (natural/biodiversity, social, economic and cultural).</p>	<p>Preferred options can be identified by considering consistency with overall community “vision” for the estuary and by community feedback about the values that will benefit.</p> <p>The views of the Expert Panel should also be considered, particularly where relative benefits require evaluation.</p>
<p>The management action is consistent with the community’s objectives for the future of the estuary. This generally implies that the community understands what is proposed (and why), that the action respects the social and cultural context of the natural resource issue and that the local (or regional) community is willing to support implementation.</p>	<p>As above, the preferred management responses will be consistent with the agreed “vision” and objectives for the estuary – this is the overall direction in which management is taking the estuary. Vision statements may reflect a preference for economic and social values or for conservation of natural values (see also HRC 2000 on the classification of coastal lakes by preferred management orientation).</p> <p>Community understanding of issues and potential management responses is difficult to evaluate. In part, it can be considered in terms of the level of discussion at community meetings, in local media; the availability of clear information (e.g. on Council’s web site and in local libraries); and through responses to the exhibition of the draft Estuary Management Plan.</p> <p>The question of community willingness to support an action can be addressed by feedback to the exhibition of the draft Plan. Willingness to support may imply willingness to pay (see below) or willingness to participate or ongoing support for council or agency initiatives (positive media coverage rather than outrage).</p>

Table 6.7 - Characteristics of Preferred Management Options (cont)

Criteria	Application and indicators
The action is affordable. This implies that the cost of the action is outweighed by its benefits. It also implies that the cost can be shared in an equitable manner (with benefits flowing to those who pay as well as others).	Preferred actions will be those whose implementation can be funded under existing natural resource or community facility programs. In some cases, Council may consider that it can make a case for special funding, or can raise a new “environmental levy” in the community. Communities and organisations may pay “in kind” by their direct participation in an action or by forgoing other benefits so that a program can be implemented. The intent is not to pass costs on to future generations (to meet the intergenerational equity component of ecologically sustainable development).
The action contributes to the protection of public assets, including community access to the waterway (foreshore reserves and associated facilities), valued views of the landscape, the health and productivity of the waterway.	In general, preference will be given to actions that protect the natural and cultural resources of the public domain. This includes the waterway (almost exclusively public land in NSW), public foreshore and access to views of valued landscapes. Actions which maintain or promote safe public access to these natural resources and places are preferred.
The action must comply with Commonwealth, NSW and local legislation, policy and Plans (including CAP). The action may inform the LEP rather than comply with an existing LEP.	Implementation of actions requires the awareness and agreement of the land owner (which could be the Commonwealth, State (Crown Land), local government (community land) or individual private owners. The Commonwealth and NSW legislation is intended to reflect and promote the community’s interest and to provide a framework for action that is based on ecologically sustainable development (as set out in the NSW Coastal Policy and NSW planning, natural resource legislation, and the Local Government Act). Regional scale plans (such as regional Planning Strategies and the CAP developed by the Catchment Management Authority) reflect the value of this system in its regional context and the management orientation that has been developed in consultation with the community. Whilst the management actions should normally be consistent with existing zoning, an important role of estuary planning is to review and inform zoning and other aspects of the LEP to ensure that they provide a suitable planning framework for the protection of estuary values.

6.4 DETERMINING PRIORITIES

This section describes how risk and other criteria have been applied to identify the priority actions for sustainable management of the Shoalhaven river estuary. **Table 6.8** shows how priority varies according to unacceptable and tolerable risks, and factors such as cost, acceptability of the response to the community, compliance with statutory and policy requirements etc.

It is clear that the highest priority actions are those that can deliver significant mitigation of high (or extreme) and unacceptable risks, but that also:

- are demonstrably the best option in the region for protecting a given value e.g. a conservation value is not better protected in a nearby estuary system);
- provide excellent benefits/returns on investment by achieving restoration or enhancement of an important value, rather than simply preventing decline;
- focus on the public domain – community access to the waterway; protection of common community assets such as water quality and vegetation on Crown land;
- provide security in terms of certainty about outcomes, and security that the benefits can be maintained without ongoing very significant investment of time or money;
- can be paid for through existing funding channels;
- are within Council's or other organisation's capacity, and particularly, do not require lengthy negotiations about shared responsibility;
- are part of the critical path in a chain of interdependent actions;
- are consistent with State government policy and with the priorities of local or regional planning strategies; and
- have strong community support in terms of willingness to pay or to contribute.

Table 6.8 establishes three levels of priority, each with an implication in terms of timely delivery.

HIGHEST PRIORITY - URGENT/IMMEDIATE (WITHIN TWO YEARS) – These actions address issues that are considered to be high risks. The actions require little further preparation, have clear definition of responsibility (Council or State agency), with overwhelming positive implications, can be funded and can be easily done as a step towards larger or more complex actions.

MEDIUM PRIORITY - TWO YEARS TO FIVE YEARS – largely Council's or a State agency's responsibility (i.e. complex co-ordination not necessary), needed to establish a baseline for future assessment of progress; Council or the responsible State agency has funds available in this time frame; the actions are precursors to other actions; the actions are clearly identified as a regional priority in Catchment Action Plan.

LOW PRIORITY - MORE THAN FIVE YEARS – require significant preparation or studies or a major co-ordination/education or negotiation program before the primary action can be implemented. Require significant funds that are not currently available. This group will include actions dependent on major state or federal funding input (beyond current program allocations); actions that are dependent on population trends/planning decisions.

ONGOING PRIORITY actions are those which are already partly implemented, but should continue. Many of these are ongoing monitoring actions, reporting or communication functions.

Table 6.8 - Priority Matrix

Level of risk presented by the issue/ Characteristics of action	Low risk, unacceptable	Low risk, tolerable	Medium risk, unacceptable	Medium risk, tolerable	High risk, unacceptable	High risk, tolerable
<p><i>ACTION CHARACTER</i></p> <p>The proposed action has a low potential to mitigate risk in this system;</p> <p>The relevant values are or could be protected in similar systems in the region;</p> <p>No funds are available;</p> <p>Very high capital, maintenance and management cost relative to benefits to values;</p> <p>Poor understanding of system reaction;</p> <p>Unpopular with local community, likely to cause a significant negative reaction;</p> <p>Inconsistent with government policy or requires a significant review of government policy position;</p> <p>Inconsistent with priorities of regional strategies or natural resource plans.</p>	Low priority	Very low priority	Low priority	Low priority	Moderate priority	Low priority
<p><i>ACTION CHARACTER</i></p> <p>The proposed action has a medium potential to mitigate risk in this system;</p> <p>There are limited opportunities to protect the relevant values in other similar systems in the region;</p> <p>Acceptable capital, maintenance and management cost relative to benefits to values;</p> <p>Some uncertainty about outcome;</p> <p>Is part of a chain of interdependent actions;</p> <p>Generally consistent with regional plans and policies;</p> <p>Consistent with State level policy.</p>	Low priority	Low priority	Moderate priority	Low priority	High priority	Moderate priority

Table 6.8- Priority Matrix (cont)

Level of risk presented by the issue/ Characteristics of action	Low risk, unacceptable	Low risk, tolerable	Medium risk, unacceptable	Medium risk, tolerable	High risk, unacceptable	High risk, tolerable
<p><i>ACTION CHARACTER</i></p> <p>High potential to mitigate risk in this system; This system presents the best opportunities to protect this value in the region.</p> <p>Excellent benefits/returns on investment in terms of values protected or restored (achieves enhancement rather than maintaining the status quo);</p> <p>Good security of outcome – certainty that benefits can be achieved and maintained;</p> <p>Funds can be made available and organisational capacity is available;</p> <p>Critical path in a chain of interdependent actions (or an important first step in demonstrating commitment);</p> <p>Is consistent with State government policy and with the priorities of local or regional planning strategies.</p> <p>Has strong community support in terms of willingness to pay or to contribute</p>	Moderate priority	Low priority	High priority	Moderate priority	Highest priority	High priority

PART 3: ESTUARY MANAGEMENT OPTIONS AND EVALUATION

This part of the Estuary Management Plan presents strategic direction in relation to major issues in each of the four key management themes for the Shoalhaven River estuary. In each case, the proposed strategy has been developed from the management objectives set out in **Section 5**.

In **Sections 7, 8, 9 and 10** a range of possible actions to address the issues that have been discussed in **Sections 4, 5 and 6** is presented. The actions are organised according to the five main management themes for the estuary. In the first instance, all actions are considered in terms of their merit in contributing to sustainable management of the estuary (and its associated coastal floodplain) as a whole. For each action, a discussion of anticipated benefits and anticipated problems/constraints/side effects is presented, leading to a conclusion as to whether, on balance, the action contributes to long term maintenance of the net value of the estuary as a whole. This discussion is based on the assessment criteria noted in **Table 6.7**.

Where necessary, **Sections 7 to 10** provide additional detail or explanation about what is intended by the action (such as monitoring programs, or new zonings etc).

Section 11 takes the actions identified as being part of long term sustainable management of the estuary and shows how they are distributed by management reach. The intent of **Section 11** is threefold:

- it shows how actions that will benefit the sustainability of the system of a whole are distributed across the system;
- it provides local scale cross referencing of the contribution of actions to the net value of the estuary, by considering whether suites of actions are consistent with each other within reaches which have a unified management orientation; and
- it helps to confirm the correct sequencing or priority of actions.

Section 11 concludes with a prioritised list of actions for the Shoalhaven River estuary, based on the analysis presented in **Sections 7 to 10**.

7.0 EFFICIENT AND ACCOUNTABLE MANAGEMENT

Objectives:

Integration of estuary and coastal floodplain management plan with regional scale natural resource management and regional land use strategies;

Estuary management strategies are within Council's, agency and community financial capacity and require a realistic level of awareness, technical skills and commitment.

Decisions about investment in estuary management activities are based on full assessment of ecological, economic and socio-cultural risk, costs and benefits.

Accountability processes are in place.

Ensure that local communities have good access to information about the health of the estuary and have real opportunities to contribute to decisions about its management.

Ensure regular review of process and outcomes so that management is adapted to take new information into account.

Other aspects of efficient and accountable management of the estuary include:

- ensure that the Shoalhaven Estuary Management Plan is accepted by the Southern Rivers Catchment Management Authority as the central strategic document for the health of the estuary, consistent with the CMA's draft Catchment Action Plan;
- minimise duplication of management effort by Council and State agencies;
- ensure that all stakeholders have an opportunity to contribute to decisions that have the potential to significantly affect the health of the estuary. Broad communication and consultation is also valuable when there is a high risk of stakeholder perception of significant impact;
- Council and agencies provide consistent signals and incentives for appropriate management to riparian land holders and waterway users;
- there is an agreed suite of indicators of estuary health, including both natural qualities and community socio-economic values; and
- estuary health indicators are reported to stakeholders (institutional and community) on a regular basis, together with information about investment that may have influenced trends in estuary health.

Table 7.1 presents a range of actions to promote an integrated, consistent and efficient approach to estuary management. **Table 7.1** also presents information about the potential benefits or difficulties associated with various management responses.

The issues in this theme are all considered to be medium to high risks to sustainable management of the Shoalhaven River estuary. The responses are low cost, in that they focus on shared information rather than capital investment.

Table 7.1 - Actions for Integrated Management

Action number	Potential Strategy or Action	Likely benefits	Possible problems	Indicative cost/benefit and priority
7.1	Ensure that CMA staff and Board members are aware of priorities in the Shoalhaven Estuary Management Plan and their relative importance in the region. CMA recognises the Estuary Management Plan as the central strategic document for the estuary.	The priority of actions in the Shoalhaven Estuary is recognised in CMA allocation of funds. CMA can influence interagency commitment to the conservation of Shoalhaven estuary values.	No specific problems identified	Positive High priority

Table 7.1 - Actions for Integrated Management (cont)

Action number	Potential Strategy or Action	Likely benefits	Possible problems	Indicative cost/benefit and priority
7.2	<p>Council continues to co-ordinate community participation in implementing management actions for the estuary through the Shoalhaven Natural Resources and Floodplain Management Committee.</p> <p>Council ensures wide representation of community interests in estuary management on this committee and designs meetings to provide opportunities for effective feedback on issues.</p>	<p>Council has an established relationship with Committee members, who represent diverse community interests.</p> <p>The SNRFMC members have a strong interest in achieving sustainable estuary management, and commitment to taking important messages to other community stakeholders.</p> <p>The committee can be regarded as an “expert panel” in the sense that it draws on both local knowledge and scientific expertise.</p>	<p>Community members are often over stretched with meetings, so careful scheduling and ensuring that meetings are valuable information sharing opportunities is essential. There have been difficulties maintaining representation of some groups and this should be addressed. For instance, special measures are usually needed to encourage Aboriginal community representation.</p> <p>Communication between CMA board community members and the SNRFMC will be important.</p>	Positive Ongoing
7.3	<p>Council, DECC, SCA, DWE and CMA continue to work together on relevant and practical EII parameters for the Shoalhaven and other south coast waterways.</p>	<p>EII is foreshadowed in NLWRA and in the comments of the NRC. It is a policy expectation of the State government.</p> <p>Shared management responsibility requires that all management partners contribute to how estuary health will be evaluated.</p>	<p>Limited baseline data is available on EII parameters for most systems and the original assessments were based on uncertain data.</p> <p>The necessary monitoring and data management may be expensive and stretch the resources of Councils and agencies.</p>	Positive High Priority

Table 7.1 - Actions for Integrated Management (cont)

Action number	Potential Strategy or Action	Likely benefits	Possible problems	Indicative cost/benefit and priority
7.4	An agreed suite in EII indicators is monitored at appropriate intervals in a joint agency/council program and the results are reported and interpreted to community members.	See Section 7.1.1 for suggested indicators. Information about estuary condition is essential to track trends in estuary health and the efficacy of management actions.	Meaningful monitoring of environmental indicators over a long time frame will be a significant cost for all involved, in terms of field time, laboratory time, analysis and reporting, data storage and maintenance. Need to be clear whether the intent is absolute data or trend information. It is preferable to focus on integrative indicators, rather than numerical data sets on individual water quality parameters that may vary within multiple timeframes.	Positive Medium Priority
7.5	Implementation of estuary management actions is consistently reported in Council's annual report, SCA annual report and CMA annual report.	All three organisations have interests in protecting the health of the estuary and responsibilities for communicating with their respective stakeholders about the level of investment in managing the natural resources of the Shoalhaven river and estuary.	Requires staff resources to ensure consistent and compatible information is presented.	Positive High Priority
7.6	Council and estuary users (such as oyster growers) continue to be represented in SCA sponsored discussion of planning for, and implementation of, environmental flow management in the Shoalhaven system.	This should reduce the risk of outrage about flow management deriving from poor understanding of intent, constraints and results. It should minimise the risk of unexpected consequences of flow management for estuary users.	No specific problems identified, other than availability of representatives.	Positive Ongoing

Table 7.1 - Actions for Integrated Management (cont)

Action number	Potential Strategy or Action	Likely benefits	Possible problems	Indicative cost/benefit and priority
7.7	Council and agency GIS systems are regularly updated with the best available environmental information (e.g. EECs, estuary health data), through streamlined data licence or data sharing agreements.	All estuary managers would have access to the same quality of management information on a day to day basis.	Potential system administration and maintenance costs – to ensure that updates occur and data quality is maintained.	Positive Ongoing
7.8	Review Environmental protection zonings in the Shoalhaven LEP and DCP requirements to ensure that they reflect significant estuary values (particularly Aboriginal heritage, biodiversity) and threats (e.g. coastal inundation).	This would give effect to recommendations for the protection of high conservation value lands and would streamline development assessment because of clear guidance about requirements and areas where development will not be approved.	Potential issues for landholders who perceive that a changed zoning narrows their land use options and/or reduces land value.	Positive High priority for necessary changes
7.9	Develop protocols for communication (with relevant stakeholders) about works that may affect estuary health to ensure minimal risk of impact on sensitive estuary users or values.	Examples include the potential impact of works on sewage infrastructure or bank protection works, or mechanical opening of the Shoalhaven Heads entrance, all of which may impact on oyster growers, commercial fishers or recreational users. Effective communication could facilitate scheduling of planned maintenance works to minimise potential risks to users (e.g. sewage infrastructure maintenance in winter rather than in summer to reduce risks to shellfish harvesting).	No specific problems identified	Positive High priority
7.10	Consistent, regular representation of Government agencies and authorities at SNRFMC meetings, and active participation in implementation of the management plan.	Actions in estuary management that are beyond the responsibilities of Council are implemented in a timely and co-ordinated manner. A more holistic approach to managing the estuary and floodplain is achieved. Agency representatives can brief the SNRFMC on current policies, priorities and actions.	Resourcing staff time to attend meetings. Budget constraints for implementing actions.	Positive. High Priority.

7.1.1 Potential Parameters for Ecosystem Integrity Index and Indicators of Estuary Health

As noted in **Section 3.2.1**, the development of an appropriate set of benchmark indicators that are relevant to or equivalent to the EII (i.e. a suite of indicators that will provide meaningful and sensitive information about extent and condition, and will also be practical and affordable to monitor) is the responsibility of the CMA (since the EII is a primary indicator of the success of CMA programs). Although Council may contribute to the monitoring of these indicators, Council does not have overall responsibility for selecting, monitoring and reporting.

DECC and the Southern Rivers CMA have appointed a project officer and are working together to identify an appropriate set of indicators for a benchmark of estuary health in the Catchment Authority's area. The project will provide a consistent and manageable set of estuary health indicators for the Shoalhaven River estuary and other estuaries and coastal lakes along the south coast.

It is anticipated that the agreed suite of benchmark (equivalent to the EII) indicators will be developed over approximately the next one to two years. This acknowledges the long time frames set by the Catchment Action Plan for demonstrating improvements. It also acknowledges the time frames necessary to distinguish short term fluctuations, within an overall long term trend.

Over time, the condition of the Shoalhaven River estuary will be reported against the indicators that are adopted after the current benchmarking project. The results of future benchmark assessments will be used to assess the success of investment in natural resource management actions in the estuary and its catchment.

8.0 SUSTAINABLE MANAGEMENT OF MORPHODYNAMIC ISSUES

8.1 MANAGING CATCHMENT FLOWS

Objectives:

The range and pattern of freshwater flows into the estuary will be managed to mimic natural variability.

Determine appropriate management responses for flood prone areas on the basis of risk to infrastructure assets and safety, acknowledging long term trends in flooding processes and hazards.

Table 8.1 summarises estuary management options related to decisions about fresh water flow regime.

These actions rely primarily on ongoing liaison between SCA and SCC, as well as SCA providing clear information about the technical studies that they have conducted to understand how changes to fresh water inflow regimes may affect the estuary.

Catchment flow issues have been assessed as presenting low risks to the health of the estuary (see **Appendix 1**).

Table 8.1 - Catchment Flow Management for Estuary Health

Action number	Proposed Management Action	Likely benefits	Possible problems	Indicative cost/benefit and priority
8.1	SCA conducts suitable hydrological and ecological studies to refine understanding of the potential long term impacts of harvesting additional medium flows. The results of these studies should be made available to Council, DECC, DWE, SRCMA, oyster growers and the SNRFMC.	Properly conducted and clearly communicated scientific studies of the potential impacts of slightly reduced flood flows and other modifications to flow or sediment transport capacity would reassure downstream managers and natural resource users that predictions of minimal risk to aquatic ecology are accurate.	Costs and timing of studies needed to give certainty to the community may preclude or be inconsistent with the timing of critical decisions about infrastructure.	Positive High priority/ongoing
8.2	SCA contributes to long term monitoring of estuary health (EII), particularly in relation to salinity and ecological issues (see Section 7.1.1).	SCA is an important stakeholder in the management of the Shoalhaven system and their management decisions may contribute to changes in sensitive estuary health indicators. This stakeholder contribution would enhance funds available for meaningful monitoring of EII.	Funding from other stakeholders to make EII monitoring feasible may not be available.	Positive Medium priority
8.3	Complete floodplain management plan and implement priority recommendations.	HRC recommended close integration of estuary and floodplain management from a natural resource perspective. The Floodplain Management Plan will provide important technical detail about flooding hazards that is not currently available, including addressing the potential for flood risks to increase with sea level rise or other aspects of climate change.	Funds may not be available to implement priority actions. However, the availability of an Estuary Management Plan and Floodplain Management Plan for the Shoalhaven will enhance access to funding.	Positive High Priority

8.2 MANAGING TIDAL FLOWS AND CURRENTS, DUAL ENTRANCE

Objectives:

Maintain a regime of minimal intervention in the opening and closing of the entrance at Shoalhaven Heads.

Maintain a safe navigable channel at Crookhaven Heads.

Restore tidal ventilation to some small tributary creeks in the floodplain, consistent with the integrated management of ASS.

The tidal regime and principal channel of the Shoalhaven estuary has been heavily modified for many years. The construction of Berrys Canal and training walls at Crookhaven Heads initiated major changes to the pattern of tidal flows in the estuary more than a century ago, and adjustments in channel size and thalweg are continuing. These ongoing changes have been assessed as an extreme risk to estuary sustainability (particularly in the context of medium term sea level rise; see **Section 8.6**). However, potential management controls are limited by significant uncertainty and excessive cost. The risks to wetlands and rural lands are considered tolerable, but not acceptable.

In addition to the major changes made primarily for historical navigation purposes, tidal flows have also been modified by the construction of levees and flood gates along some sections of the floodplain. In this case, the structures had the intent of protecting flood prone settlements and improving drainage of agricultural land. These structures have subsequently been linked to loss of floodplain wetland habitat and to the discharge of acid into the river (particularly from the Broughton Creek section of the floodplain). The risks to floodplain wetlands and EECs have been assessed as high to extreme. Management actions are described in **Section 9**.

Table 8.2 presents potential management strategies for tidal flows in the Shoalhaven estuary. The strategies noted in **Table 8.2** should be considered in association with strategies in relation to sea level rise (in **Table 8.6**).

The Shoalhaven River estuary has two natural entrances. It is apparent that the significance of these entrances in terms of the passage of the majority of tidal flows, has switched between the Shoalhaven Heads entrance and the Crookhaven Heads entrance in the past. Since the construction of training walls at Crookhaven Heads and the construction of Berrys Canal in the late nineteenth century, Crookhaven Heads has provided a permanent open and navigable entrance channel to the estuary, but Shoalhaven Heads has opened only intermittently.

Table 8.2 - Managing Tidal Flows and Currents

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.4	Review the entrance management policy for Shoalhaven Heads at regular intervals, and link to appropriate minimum floor levels for any future development, including taking into account the effects of sea level rise on 1%AEP flood events (floor levels are set by the Floodplain Risk Management Plan). (See SCC Policy POL05/49, affirmed September 2005).	The dry notch at Shoalhaven Heads may not, on its own be sufficient to mitigate flooding impacts on some 683 properties at Shoalhaven Heads (i.e. properties affected if the entrance is closed during a 1%AEP event). It may not be safe to open the entrance during a major flood. The high floor levels imposed by the policy are intended to ensure that new development does not increase the risk (value of property affected) by flooding.	Land holders must be aware of the requirements of the policy and of the safety issues associated with opening the entrance artificially in flood conditions.	Positive High priority
8.5	Allow channel adjustments at Berrys Canal to continue (see also Section 8.5).	Berrys Canal has widened by at least 80 metres over the last 60 years. The channel as also deepened and new intra channel meanders have developed within the widened canal. Tidal current velocities though the canal are very high. Deep water undercutting of the shoreline is extremely difficult to modify.	Further habitat around the southern and western shorelines of Comerong Island will be lost, with limited opportunities for conservation offsets.	Positive Ongoing
8.6	Prepare community information about the dynamic nature of the lower Shoalhaven estuary and the impacts of historic channel modification on estuary dynamics.	Most local people are aware of the historic excavation of Berrys Canal, but perhaps less aware of the implications of the canal for tidal processes in the lower estuary. High velocities in the canal also have implications for boating safety.	Need to be clear about target audience and style of information that would be useful.	Positive Low to medium priority

Table 8.2 - Managing Tidal Flows and Currents (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.7	Maintain the integrity of the training wall at Crookhaven Heads, to provide a safe navigation channel for recreational vessels and commercial fishing vessels.	Safe boating is an important local community objective for the estuary and is also a significant attractor for visitors.	Ongoing maintenance costs.	Positive Ongoing maintenance of the wall.
8.8	Prepare and communicate emergency response plan for low lying areas of Shoalhaven Heads Village as part of the Floodplain Management Plan and Entrance Management Strategy.	Some older residences at Shoalhaven Heads are flood prone and have floor levels below that set for more recent development. A clear emergency response strategy for flood events contributes to the safety of residents, and allows less intervention in the opening of the estuary entrance.		Positive Moderate to high priority
8.9	Maintain regular surveillance of shoals inside Crookhaven Heads and install channel markers as necessary to ensure the safe channel is clearly marked. Mark shoals on new editions of boating maps. Liaise with local boating groups about the installation of channel markers. Similarly, shoals in the upper estuary should be monitored in relation to safe boating issues, channel markers installed in high usage areas, and maps marked/amended as necessary.	Complements the proposed occasional maintenance dredging of the tidal delta at Crookhaven Heads. Fosters communication between boating groups/waterway users and NSW Maritime. For the upper estuary, monitoring of shoals and communicating navigation dangers that may arise will complement other measures to foster safe management of powered and non powered recreational boating.		Positive Ongoing

Table 8.2 - Managing Tidal Flows and Currents (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative case/benefit and priority
8.10	Dredge shoals only if safe navigation is compromised by excessive channel narrowing and shallowing, so that clear channel marking is ineffective.	Simple approach to minimise risks to safe navigation.	Funding not available for maintenance dredging at necessary times; poor communication about changing risks due to gradual accretion.	Beneficial only if risks increase. Low to medium priority.
8.11	Investigate methods to improve tidal ventilation past structures such as floodgates, particularly when tidal flows to high value floodplain wetlands (estuarine) have been affected (see also Table 9.1 – re habitat management in floodplain wetlands). Section 8.2.2 has details of potential priorities.	The benefits of improved tidal flows are improved resilience and diversity of floodplain wetlands, improved resistance to other disturbance impacts. Associated benefits from better fish passage and fishery habitat. The aims are to achieve these benefits without significant detriment to floodplain productivity.	Modifications of floodgates and other structures to improve tidal flows must take into account the potential for tidal overtopping of the drains and the potential for salt seepage into productive agricultural land (see Section 4.1.1.1 and DPI 2003). Council has airborne laser scanner elevation data for the floodplain, which can be used to model the effects of opening floodgates at different locations, and the effects of sea level rise on drain overtopping etc.	Important action for integrated floodplain management, and a property because of lack of suitable management information for most structures.

8.2.1 Shoalhaven Heads Entrance Management Policy

Council is continuing to monitor and review the Entrance Management Policy for Shoalhaven Heads. The policy implements the policy recommended by the HRC (1999) that a permanently open entrance is not practical or ecologically appropriate at Shoalhaven Heads. There are benefits for fishery habitats with the natural variation in entrance conditions and current fluctuations in water quality when the entrance is closed do not justify an engineered increase in tidal flushing. A dry notch in the berm at Shoalhaven Heads is set at 2m AHD, linked to the floor level for development in the village to protect it from flooding. Appropriate levels for both the dry notch and floor levels should be reviewed as new and more definitive information about sea level becomes available.

In accepting that the entrance area at Shoalhaven Heads is subject to major changes in sand volume and elevation, the efforts of Bushcare and Dunecare workers in this area should focus on activities which are consistent with the Shoalhaven Heads Entrance Management Plan, which sets out management criteria to be implemented and maintained.

8.2.2 Tidal Ventilation of Floodplain Wetlands

The Department of Primary Industries has prepared comprehensive guidelines about how to make decisions about part or full opening of floodgates that control tidal flows into drains in coastal floodplains (DPI 2003). These guidelines provide information about risks associated with floodgated drains and advice about matters that must be considered when considering changes to floodgate operation or drain/floodgate design. In particular, the DPI (2003) guidelines (see also **Section 4.1.1.1**) note the importance of understanding the hydraulic processes operating on the floodplain, when determining the best management strategy for floodgated drains in floodplains used for agriculture or conservation. Salinity, nutrient and acid issues all need to be considered.

Williams, Watford and Taylor (1996) reported on restrictions to tidal flows in NSW estuaries. They note a total of 74 culverts, causeways, weirs, floodgates and agricultural drains that affect tidal flows between the Shoalhaven/Crookhaven estuaries and channels and wetlands on the coastal floodplain. **Table 8.3** summarises the structures, with comments relating to significance. These comments draw on the limited description provided by Williams, Watford and Taylor (1996) and information about the vulnerability or habitat value of wetlands that are upstream of the structures.

DPI is currently conducting further research into the priority structures for improved management (or removal) for south coast estuaries. The preliminary assessment in **Table 8.3** suggests that the important structures for further investigation of improved management options include those affecting the Nature Reserves at Brundee Swamp and Saltwater Swamp, the floodgates on Crookhaven river (behind Greenwell Point) and the multiple floodgates and other structures that affect Terara Swamp. Terara Swamp appears to be heavily degraded (and does not contain any remnant EECs), so would be a lower priority than the wetlands that are in relatively good health. Because of their association with acid sulfate soil issues, several structures in the Broughton Creek catchment (e.g. those along Swamp Roads east and west) should also be investigated further.

As noted above, decisions about the best management strategy for all of these floodgates will require consideration of fish passage issues in association with:

- the potential for salt intrusion into agricultural soils (by subsurface hydraulic conductivity);
- the potential for saline or brackish water to enter fresh water wetlands;

- the potential for drains to overtop with tidal water, inundating agricultural land with salt water; and
- the buffering capacity of the drains to neutralise acid.

So floodgate management must be conducted in the context of whole of floodplain management.

Table 8.3 - Structures that impede tidal flows to floodplain creeks and wetlands

Structure	Comments
Culverts, Coomonderry Swamp	Culvert inverts on Shoalhaven Heads Rd and Bolong Rd are too high for tidal flows; Significant, but outside current project area
Culvert, Terara Swamp	Invert is too high
Culvert, Bevan Creek	Diameter too small
Floodgates, Coomonderry Swamp	Significant, but outside current project area
Floodgates on unnamed drain near Coolangatta Road	Likely to be outside current project area
Floodgates on unnamed drain near Swamp Road East	Swamp Road East and West traverse multiple drains across former wetlands in the Broughton creek catchment
Floodgates on unnamed drains and Snake Island Creek, near Back Forest Road.	Relatively small catchment affected
Floodgates on unnamed drain near Wharf Road	
Floodgates on unnamed drain near Swamp Road west	Affect large area of former wetland on Broughton Creek floodplain
Floodgates on unnamed drain near Sopers Road	Main drain for wetland area behind paper mill
Floodgates on unnamed drain near Jennings Lane	
Floodgates on unnamed drain and Abernethys Creek near Bolong Road	
Floodgates on Terara Swamp near Terara Road, Comerong Island Road and Numbaa Road	Significant impact on Terara Swamp – no EECs mapped in this wetland?
Floodgates on unnamed drain near Numbaa Road	
Floodgates on unnamed drain and Macdonald Creek	At entrance to Shaws Creek
Floodgate on Crookhaven River near Culburra Road	Affects Saltwater Swamp Nature Reserve and Brundee Swamp Nature Reserve – likely to be significant
Floodgates on unnamed drains near Bournes Lane	
Floodgate on Crookhaven River near Jindy Andy Lane	Blocks upper Crookhaven River and potential flows from Crookhaven to Terara Swamp
Floodgate on Crookhaven River near Greenwell Point Road	Also affects Terara Swamp
Floodgate on unnamed drain near Springbank Road	Connects Crookhaven River to Crookhaven River
Floodgate on Crookhaven River at Eelwhine Creek	Eelwhine Creek loops back to Crookhaven River – not through major wetland areas
Floodgate on unnamed drain near Pyree Lane	Minor catchment area
Agricultural drains at Coomonderry Swamp and Broughton creek	Acid sulfate soils affected

Table 8.3 - Structures that impede tidal flows to floodplain creeks and wetlands (cont)

Structure	Comments
Agricultural drain and pump on unnamed drain	
Levees and blockages at Abernethys Creek, Regatta Creek, Berrys Canal and Ryans Creek	Affect Numbaa Swamp and Saltpan Swamp

8.3 MANAGING BANK EROSION/CHANNEL CHANGE – DOWNSTREAM OF NOWRA

Objectives:

Respond to ongoing channel migration in accordance with risks to important ecological, productivity and amenity values.

Control activities that drive bed and bank erosion outside the anticipated impact of natural flow variability.

Protect and restore the connectivity of riparian and floodplain habitats.

Sediment transport and localised in channel erosion/deposition are within the range anticipated from the natural flow variability of the Shoalhaven River system.

Table 8.4 presents potential management strategies to address channel change in the lower estuary, taking into account the recommendations of several previous studies and the strongly cautionary position of the HRC.

Bank erosion in the lower estuary is considered to present high risks to ecological values, particularly around Comerong Island. In other areas, bank erosion affects agricultural land. Along the north bank opposite Pig Island, bank erosion affects industrial land, and at Greenwell Point, wind waves and tidal scour affect an important foreshore recreation reserve.

Detailed design work for any structural controls in the lower estuary should be informed by appropriate hydrodynamic studies.

8.4 MANAGING BANK EROSION/CHANNEL CHANGE – UPSTREAM OF NOWRA

Objectives:

Control activities that drive bed and bank erosion outside the anticipated impact of natural flow variability.

Protect and restore the connectivity of riparian and floodplain habitats.

Table 8.5 presents potential actions to minimise the threat that bank erosion in the upper estuary presents to significant estuary values. It is important to note that recreational boating and floodplain agriculture/grazing, which drive some bank erosion issues, are also community values for this area, whose maintenance will contribute to sustainable estuary management.

Previous studies (e.g. Patterson Britton 2005) have made detailed recommendations about measures or works to control bank erosion in the upper estuary. The options presented in **Table 8.5** take this previous work into account, but moderate the options in the context of information about risks to estuary values.

8.4.1 Accretion in the Channel Upstream of Nowra

Waterway users report some shoaling in the upper estuary, affecting the safety of navigation upstream of Long Point. Changes in these shoals are most affected by flood flow, especially in the Burrier, Barringella and Calymea Reaches. However, tidal currents and lower velocity river flows also assist with reworking of sand slugs deposited by floods. These sedimentary processes are part of the natural behaviour of the upper estuary, where fluvial sediment load is high.

From a user perspective, safe navigation is the main issue. This can be managed providing information to waterway users, by reducing boat speed, and encouraging non powered or low powered vessels (canoeing, bass fishing). This is discussed in **Section 10 (Table 10.3)**.

Table 8.4 - Options for Managing Bank Erosion/Channel change in the Lower Estuary

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.12	Do nothing and allow current processes to continue unabated in the lower estuary.	Low capital cost.	<p>This is not necessarily a low cost option, as there will be no mitigation of erosion impacts on recreation areas or habitat values.</p> <p>However, the cost and disturbance caused by structural controls in some locations do not support this type of intervention.</p> <p>Will continue high level of uncertainty and debate in the community about cause and responsibility.</p>	<p>May be negative or positive.</p> <p>Generally only a relevant option for very low risk examples of bank erosion.</p> <p>However, no intervention is also proposed for the erosion along Berrys Canal, which affects high conservation value wetlands.</p>
8.13	Fence riverbanks to exclude cattle access/trampling and destruction of riparian vegetation, focusing on specific locations in the lower estuary (between Pig Island and Numbaa Island).	<p>Benefits of cattle exclusion in the lower estuary relate more to biological water quality than to bank stability. Cattle grazing is not noted as a significant driver of bank collapse, although poor riparian vegetation cover may exacerbate the impacts of tidal and flood scour on unconsolidated (sandy) bank material.</p> <p>Overall, riparian vegetation programs are more likely to be successful when cattle grazing and trampling are minimised.</p>	<p>Investment should be directed towards riparian vegetation recovery rather than expecting significant benefits for erosion at severely affected sites.</p> <p>Ensure expectations of revegetation programs are realistic, with performance evaluation not tied to bank stabilisation at sites where flood scour or tidal scour are critical factors.</p>	<p>Positive, but for ecological rather than morphological reasons.</p> <p>Medium to high priority.</p>

Table 8.4 - Options for Managing Bank Erosion/Channel change in the Lower Estuary (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.14	<p>Fence off riparian zones. Where fencing is considered appropriate, provide incentives for land holders to encourage investment (for instance through assistance with property management plans, loans and voluntary conservation agreements).</p> <p>Alternatively, where fencing is considered appropriate, require riparian zones fencing as a condition of all future development approvals and/or water licence renewals (if water is extracted for agricultural purposes). (see also Sections 9.2 and 9.3).</p>	<p>Both approaches can be used concurrently, with a tax incentive or low cost loan arrangement to assist farmers to install required fences and off stream water supply for cattle. Rivercare can contribute to habitat continuity by working on intervening public land.</p> <p>The benefit of providing clear incentives is that fencing of critical sections of bank may be achieved more quickly.</p> <p>Incentives should also apply to fencing of floodplain wetlands where cattle exclusion would encourage restoration of habitat values.</p>	<p>Cost shifting from individual property owners to general community. However, the benefits of improved riparian habitat accrue to a range of other stakeholders, through improved aquatic productivity, aesthetics and reduced costs for other types of bank protection.</p>	<p>Positive, particularly incentive based approach.</p> <p>Medium priority – requires significant negotiation and funding.</p>
8.15	<p>Ensure that all riverbank (outside existing urban areas) is zoned Rural or Open Space or Environment Protection, with intensive development of high hazard sections excluded.</p>	<p>The intent is to minimise risks to property and infrastructure wherever possible.</p> <p>Most riverbank is already in these zones.</p>	<p>May require back zoning in a few locations.</p>	<p>Positive.</p> <p>Medium priority.</p>
8.16	<p>Identify any reach where monitoring of erosion near existing development/services should be conducted so that bank retreat (and associated impacts on infrastructure or built assets) can be effectively planned.</p>	<p>There are no high priority locations for planned retreat at this time. However, active erosion sites should be monitored where there is potential for threats to roads, wharves or farm pumps etc.</p>		<p>Medium priority.</p>

Table 8.4 - Options for Managing Bank Erosion/Channel change in the Lower Estuary (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.17	Identify and assess any alternative communities/habitat that can be conserved to maintain equivalent values to Comerong Island in the estuary. See also Section 8.5 in relation to this approach to habitat threatened by sea level rise. Negotiate conservation agreements for suitable offset habitat areas.	This action supports the EII monitoring action for Comerong Island and the wetland/saltmarsh habitats at Bevan Island/Old Man Island. It is also linked to actions to provide conservation management for habitat that is threatened by long term sea level rise (see Table 8.5).	Limited alternative conservation areas for saltmarsh are available in the Shoalhaven River estuary.	Conservation offsets for sea level rise or other long term bank erosion issues would be a positive outcome. Low to medium priority, with significant negotiation necessary, potentially land acquisition.
8.18	Include area and health of endangered ecological communities and habitat suitable for migratory waders in Ecological Integrity Index, so that ecological risks associated with retreat of banks at Comerong Island are monitored.	Recommended action is to allow channel adjustments to continue at Berrys Canal. However, there are significant habitat consequences which need to be monitored, particularly as impacts of sea level rise begin to affect key habitats.	Agency agreement on appropriate indicators for EII; costs of monitoring.	Positive. High priority.
8.19	Replant reed beds and/or mangrove along toe of banks where wind waves contribute significantly to erosion processes.	This planting will help reduce the wave energy impacting on the toe of the bank. The western shore of Comerong Island is an example. Temporary wave breaks may be necessary to allow plants to establish.	High wave energy may inhibit establishment of fringing vegetation. Where tidal or flood scour currents also contribute to erosion, there may be deep water adjacent to the bank, restricting colonisation potential. Not appropriate for sites where community infrastructure or buildings would be threatened by erosion.	Positive, provided wind waves are the dominant process and replanted areas will not be undercut by deep current erosion. Ongoing and moderate priority.

Table 8.4 - Options for Managing Bank Erosion/Channel change in the Lower Estuary (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.20	<p>Manage sediment load at depositional sites in the estuary, to reduce impetus for migration of the thalweg – e.g. by dredging accreted areas at Pig Island and Numbaa Island. Maintain records of all sand removed from the system.</p> <p>A DA is with Council for Terara Sands to place dredge spoil on Pig Island. Dredged sand could potentially be used for work elsewhere in the estuary – e.g. along eroding banks or to build up shoals for waders.</p>	<p>There is some evidence that accretion of Pig Island is contributing to thalweg migration, increasing the erosion hazard along the north bank of the estuary. Controlled dredging would provide valuable construction material, and may also help to reduce the erosion pressure.</p> <p>However, alternative applications for the sand should also be considered. These would include maintenance of wader habitat or near shore bank areas in the lower estuary. Such applicants would require studies of likely effects of sediment deposition on estuary processes.</p>	<p>Dredging design should not create deep holes. Timing and availability of sand is partly controlled by large flood events that move significant quantities of sand in the mid estuary.</p> <p>Sediment transport to sites away from Pig Island and Numbaa Island for restoration purposes is likely to be costly.</p>	<p>Positive action, depending on ongoing accretion and sand supply from floods.</p>
8.21	<p>Construct rock walls or groynes to protect severely eroding banks (reduce the rate of retreat), where retreat threatens recreation reserves or major infrastructure.</p>	<p>Appropriate for sites in Nowra - formal recreation shoreline. Groynes suggested as part of the management at Greenwell Point Reserve, to improve sand retention on the beach and reduce current scour.</p>	<p>Extremely high capital cost option where erosion is driven by deep current scour; only suitable for shorelines requiring a formal face to the river (some urban areas with high recreational use) or to protect major infrastructure investment.</p>	<p>Positive for only a few sites. For other locations, vegetation rehabilitation should always be the first management approach.</p>

Table 8.4 - Options for Managing Bank Erosion/Channel change in the Lower Estuary (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.22	Construct groynes or other structures to maintain recreational foreshore – beach and shallow near shore with low current velocities.	This option is really only relevant to Greenwell Point.	Moderate cost.	Recommended as a medium to high priority for Greenwell Point, as part of enhancement of the foreshore of an Icon Park location.
8.23	Monitor the condition and location of banks at regular intervals (e.g. approximately five years), by aerial photograph analysis supported by some ground-truthing of features such as undercutting and health or riparian vegetation.	There have been multiple studies of bank erosion in the estuary, most recently in 2004/05. Although some sites have been identified as issues in each study since 1977, others have only been identified in later studies. Ongoing monitoring using current aerial photos will provide information about sites whose priority for intervention (or the type of intervention necessary) changes over time.	Resources at Council or DECC.	Positive – and an important action for improving understanding of channel processes. Medium Priority.
8.24	Install baffles or other structural devices to reduce wave impact on banks.	Complements planting actions for banks where wave erosion is important.		Moderate priority.
8.25	Design and implement a community awareness/education program on the dynamic nature of the Shoalhaven estuary channel and constraints to stabilisation. Importance of adaptive living.	The extent of past channel change is a particular feature of the Shoalhaven estuary. Overall expert opinion is that the effects of structural intervention at major erosion sites is not sufficiently predictable and may have severe unforeseen consequences.	Design and distribution of appropriate community information - not an 'urgent' issue, but part of raising general community awareness of the complexity of the natural system.	See also Table 10.6 . Moderate priority.

Table 8.4 - Options for Managing Bank Erosion/Channel change in the Lower Estuary (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.26	Manage boat speed or other behaviour close to banks where boat waves contribute to erosion.	This action is more appropriate to the upper estuary, where many reaches are much protected from wind waves and tidal velocities are relatively low.	In the lower estuary, exposure to long wind fetch is more likely to generate erosive waves.	Medium priority, part of a Boating Management Plan.
8.27	Identify and promote specific swimming areas which are not affected by high current velocities and deep water (see Section 10.3). Locations where currents or deep water pose a hazard for swimming should be signposted to alert swimmers to hazards.	These are primarily adjacent to existing foreshore reserves such as at Shoalhaven Heads. The aim would be to encourage use of safer swimming locations.	Must comply with Council's policy re hazard identification for users of public lands.	Low priority.

Table 8.5 - Options for Managing Bank Erosion in the Upper Estuary

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
8.28	<p>Protect fringing reed beds or mangroves along the banks of the upper estuary. This may involve:</p> <ul style="list-style-type: none"> • fencing of high banks of pocket floodplains to exclude cattle (and provision of offstream watering points for cattle); and • encouraging replanting of reed beds in the river where they have been previously degraded by grazing. 	<p>There is good evidence that excluding cattle from steep unconsolidated banks in the upper estuary reduces slumping and allows vegetation to recover. Riverwatch in the Shoalhaven has demonstrated the benefits of replanting (or encouraging natural recovery) reed beds. The presence of reedbeds along the bank helps to reduce wave impacts (from boats and wind waves).</p>	<p>Land holders may require incentives to address costs associated with changed grazing and watering patterns. Community groups such as Riverwatch need technical and funding support.</p>	<p>Positive. High priority.</p>
8.29	<p>Encourage revegetation of unconsolidated high banks to reduce seepage impacts and address bank stability and biodiversity objectives. Prioritise sections of bank where revegetation will also contribute to restoration of habitat continuity along the bank. Preference should be for native river bank species, to address biodiversity objectives as well as bank stability objectives. Focus on sections of bank where revegetation will contribute to restoration of habitat connectivity along the bank.</p>	<p>Vegetated banks will be more resistant to undercutting processes, whether from rapid draw down of saturating flood flows, or from wave impacts. See Section 9.2 in relation to habitat connectivity benefits. Stable vegetated banks are protect or restore aesthetic values for passive recreational users and contribute to fish habitat (shading etc) in the upper estuary.</p>	<p>Revegetation of steep banks requires careful management to maximise the potential for plant growth. Riverbank vegetation will not always protect vulnerable banks from erosion (e.g. in major flood events) and some losses should be expected. Without information in the community about expected responses, this could be interpreted as poor selection of management technique.</p>	<p>Medium priority.</p>

Table 8.5- Options for Managing Bank Erosion in the Upper Estuary (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
8.30	<p>Prepare and implement a Boating Management Plan for the estuary. The Plan should address the stability of banks that are directly impacted by boat waves. Improvements could be achieved by requiring offsets from the bank for turns, or planing speeds at certain locations, or low boat speed through vulnerable reaches.</p> <p>The Boating Management Plan could include the use of navigation markers for persistently shoaled areas of the upper estuary, to assist with safe boating management (see also Action 8.9).</p>	<p>NSW Maritime has commenced the preparation of a Boating Management Plan for the Shoalhaven River Estuary. Potential benefits of management of boat speed/wake generation include reduced conflict with other waterway users and land holders (noise, safety, perceptions of crowding etc), as well as reducing pressures on vulnerable banks (e.g. susceptible to wave undercut and block collapse).</p>	<p>Potential to reduce the viability of the Shoalhaven as a preferred ski venue, with indirect impacts on tourism activity and revenue.</p>	<p>Positive. High priority. Preparation of a Plan is in progress.</p>
8.31	<p>Maintain structural controls on some sections of river bank.</p>	<p>This approach is generally not recommended for the upper estuary. However, at Nowra Ski Park and in Greys Reserve (adjacent to the regional boat ramp), structural controls are already in place. At these locations which experience very high boat traffic in accelerating and decelerating speed patterns, structural bank protection should be maintained.</p> <p>Structural controls opposite Greys Reserve may also benefit the connectivity of the town centre and the river by facilitating a riverbank walk.</p>	<p>Structural controls are expensive to construct and maintain. Whilst they enhance pedestrian and other terrestrial access along the bank, they can impede boating or swimming access to the waterway, without additional design features.</p> <p>There are also potential local impacts on habitat value – these are minor when only selected reaches are treated with structural controls, and the potential long term impact (on ecological values) of continuing erosion at those sites is taken into account.</p>	<p>Positive for specific sites. Medium priority for Nowra area.</p>

8.5 ACCOMMODATING SEA LEVEL RISE AND OTHER ASPECTS OF CLIMATE CHANGE

Objectives:

To maintain awareness of best estimates of sea level change and of estuary values that are threatened by rising sea level superimposed on other impacts.

To focus conservation efforts on buffers around vulnerable habitats where terrain would facilitate habitat migration in response to sea level rise.

To focus conservation efforts on vulnerable habitats that are unlikely to be lost due to sea level rise (this requires that other impacts on sustainability are controlled).

The risk assessment (see **Appendix 1** and **Section 6.2**) identified climate change as a very significant issue for the long term sustainability of estuary values. Sea level rise, in particular, has the potential to intensify a number of estuary processes. Both channel change and bank instability may be exacerbated in the lower estuary; shoaling patterns may change, and increased water levels may inundate intertidal habitats which have limited opportunities to migrate or retreat. These changes to physical and ecological processes may have repercussions for fishery, oyster industry and agriculture values.

Table 8.6 presents options for adapting to sea level change and to other aspects of climate change which are expected to occur over the next 50 years or so. Initially, most of these actions offer awareness raising and information benefits. However, some actions are designed to create a land use situation where important habitats can best adjust to long term changes to water levels, water temperature or water chemistry etc.

Table 8.6- Adaptive Responses to Sea Level Change and other aspects of climate change

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.32	Identify locations where salt marsh habitat has potential for roll back (migrate landward) as sea level rises and encourage landholders to enter Voluntary Conservation Agreements to protect these areas.	These sites are almost entirely restricted to the lower estuary (Zones 4, 5 and 6, downstream extremity of Zone 3). The intent is to manage buffer land around existing saltmarsh communities in particular, selecting sites which have low gradients away from existing mean high tide level.	Negotiation process for land acquisition or changes to management. Limited sites are possible, mostly on Bevan/Old Man Island.	Commencement of this process is a high priority.
8.33	Include information about sea level change in Council's SoE or similar regular reporting.	Helps raise general community awareness of the best available information about rates of sea level rise and potential changes to the estuary. Regular council reporting is widely available to local residents and is presented by a local authority – perhaps more likely to be read than information at a higher strategic level.	Most detailed local predictions of landscape response to climate change are still generic and may be misleading.	High priority to commence providing this information to residents.

Table 8.6 - Adaptive Responses to Sea Level Change and other aspects of climate change (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.34	Remove priority barriers to fish passage in the upper reaches of the estuary and estuarine tributaries to allow ongoing fish access to migrating habitat as sea level rises. This reason for managing structures such as floodgates and culverts is separate to the justification for removing floodgates lower in the system (for habitat restoration rather than migration)	DPI has prepared an audit of key barriers to tidal flows (see Section 8.2.2 and Table 8.3). These barriers also block fish passage. As sea level rises, salinity will rise in the upper reaches of the estuary. Removal of barriers to fish passage allows fish to move past the new tidal limit into evolving habitat. Contributes to protection of fish stocks in the estuary.	Careful design of measures to allow fish passage and tidal ventilation is necessary to minimise threats to other floodplain values.	High priority. The combined benefits of improved fish passage and tidal ventilation of floodplain habitats make this an important action. See also Section 9 for other biodiversity actions.
8.35	Monitor and report the effects of sea level change on the extent of shoals used by migratory waders/shorebirds and the numbers of birds using the shoals on an annual basis.	The lower Shoalhaven is visited by large numbers of migratory waders that are the subject of international conservation agreements. They use shallow shoal habitat. As sea level rises, these shoals may become permanently inundated, although new shoals may also emerge. The action is to improve understanding of the variability of habitat conditions that these important species can tolerate, so that alternative habitat can be created if necessary.	The availability of an agreed suite of indicators and funds to implement the monitoring - possible timing and funding issues for effective monitoring of a useful measure of migratory wader habitat. DECC and SRCMA are working together on an appropriate mix of indicators.	Ongoing priority can utilise local representatives of birds Australia, as well as involving DECC and Commonwealth DEH.

Table 8.6 - Adaptive Responses to Sea Level Change and other aspects of climate change (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.36	Review zoning of land that may be affected by tidal or storm inundation if sea level rises and ensure appropriate planning controls are in place. Council is preparing a new LEP over the next three years. New zones should reflect the risk of flooding.	See Recommendations in Council's Floodplain Management Plan. Appropriate controls for new development are intended to minimise any additional risk over a 50 year planning horizon.	Will not address increased risk to existing development.	Medium priority, following completion of flood studies.
8.37	Update boating maps to show current extent of shoals that may affect navigation channels and provide information at major boat ramps.	See Tables 8.4 and 10.3.	See Tables 8.4 and 10.3.	Positive cost/benefit. Medium priority.
8.38	Review and update design guidelines for sea walls and jetties (on waterfront residential properties e.g. see Plate 4.3), subject to sea level rise. The action relates primarily to Greenwell Point, which has some absolute waterfront properties (rather than waterfront reserve). Include requirements in DCP.	Council's existing wharves and jetties Policy addresses public/private land issues, dimensions and development consent. Design of sea walls where essential to protect property should also consider ecological benefits and public access issues. This action proposes the provision of guidelines for future sea walls and jetties, addressing all these matters, but also designs that are appropriate for shorelines that are threatened by inundation with predicted sea level rises.	Can only be effective when a new wall or significant repairs, requiring development consent, is proposed.	Low to medium priority. Only a small number of properties are involved.

Table 8.6 - Adaptive Responses to Sea Level Change and other aspects of climate change (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
8.39	Prepare climate change risk reduction guidelines for oyster industry, focusing on potential storminess and more frequent high temperature days.	Significant losses of oysters on production leases can occur if measures are not in place to protect them from high winds and wave associated with storms and with exposure to high temperatures. The Shoalhaven (Crookhaven) is regarded as a priority oyster production area, so clear guidance on precautions for these events is desirable.	Link to design of production leases and flexibility to allow oysters to be moved below water. Pumps can be used to irrigate oysters during hot weather, but noise issues for leases that are adjacent to residential areas – guidelines will need local area consultation to be effective.	High priority because these events cause losses now. The situation is expected to worsen in the future if the number of hot summer days increases.
8.40	Maintain records of algal and phytoplankton blooms in the estuary, as possible indicators of changing water chemistry.	One of the potential impacts of climate change is changes in water temperature and chemistry that would encourage algal blooms. If these occur there are flow on effects for fishery and oyster production, as well as for recreation and tourism.	Needs to be considered as part of the EII – agreement needed on parameters and responsibilities. Other factors may also drive algal/phytoplankton blooms.	Ongoing priority. Major blooms should be reported to DECC and DPI now.

9.0 ACTIONS TO PROTECT AND ENHANCE BIODIVERSITY

As noted in **Section 4.1**, the Shoalhaven River estuary and its associated coastal floodplain contain remnants of a wide range of coastal zone habitats. These habitats can be broadly divided into aquatic (estuarine) and floodplain (riparian, woodland and wetland habitats). Terrestrial habitats (sandstone forest/woodland) border some parts of the upper estuary.

In general, the aquatic habitats have, to date, been less impacted by land and waterway use than have the floodplain habitats. Many floodplain habitats are now in degraded condition and connectivity within and from the riparian zone along the channel is very poor. Despite this, the Shoalhaven wetlands are believed to be important habitat for the Green and Golden Bell Frog.

Although many of the floodplain habitats have been drastically altered, the estuary contains some of the most extensive areas of estuarine wetland habitat on the NSW south coast (partly because of the overall magnitude of the Shoalhaven system). The lower estuary is visited by some 27 species of migratory waders that are subject to international agreements (and therefore protected under EPBC Act). The biggest ongoing threat to aquatic habitat is the continued widening of Berrys Canal. Channel widening has already removed a width of 80 metres (or more) of mangrove and saltmarsh habitat along several kilometres of Comerong Island and Nobles Island as the bank has retreated.

As discussed in **Section 6**, floodplain management and ongoing channel widening/realignment are significant threats to the biodiversity values of the estuary. Other important threats include barriers to fish passage, and a range of impacts that are likely to occur with long term climate change or sea level rise. Water quality impacts on biodiversity (other than acid sulfate issues in the Broughton Creek catchment) have, to date, been relatively minor.

Sections 9.1 to 9.5 address various aspects of biodiversity management, with actions summarised in **Tables 9.1 to 9.4**.

9.1 STRUCTURES AND LANDUSES THAT ENHANCE OR RESTRICT BIODIVERSITY OUTCOMES

Objectives:

To protect and restore the connectivity of riparian and floodplain habitats.

To protect and restore the ecological diversity of locally indigenous riparian plant communities and habitats.

To manage water quality variability within the range and rate of change that is suitable for protection of aquatic habitats in both the upper and lower estuary.

To remove barriers to fish passage

This group of objectives and associated actions address specific structural constraints to habitat restoration in the estuary. Floodgates, culverts etc that block tidal flows and restrict fish passage are the main issues. However, aspects of bank erosion, bank controls and flood mitigation structures are also relevant, because of the impact that they have on the local details of aquatic habitat (pools, low tide benches, shoaling, channel alignment and velocity etc.).

Estuarine aquatic communities are naturally very variable in the distribution and character, reflecting short to medium term variability in catchment runoff, tidal influence, etc.

Table 9.1 discusses the options for managing structures along the estuary, including sea walls, flood mitigation structures, and engineering works to protect assets on eroding banks.

Table 9.1 – Structures, Land use and Biodiversity

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.1	Implement Brundee Swamp and Saltwater Swamp Plan of Management in relation to habitat protection.	Both of these wetlands are Nature Reserves with significant vegetation communities. They are also important habitat for the Green and Golden Bell Frog. Restoration and protection of the health of these wetlands would provide a strong base for connections with other smaller areas of quality habitat across the floodplain.	Principally a DECC responsibility and resources may be limited. Some actions will also require the co-operation of adjacent landholders, and ongoing negotiation may be required.	Positive. High priority.
9.2	Minimise vehicle access to floodplain wetland areas, particularly those in existing Nature Reserves. See also Action 9.5 .	This is a general action which recognises that recreational vehicles can seriously damage sensitive wetland habitats. Reducing vehicles and cattle in the core wetland habitats will reduce trampling/wallowing of wetland habitats.	Some vehicle access may be essential for fire management. Potential costs to landholders of fencing and surveillance (e.g. illegal access).	Positive. High priority, in concert with other actions to enhance the ecological health of floodplain wetlands.
9.3	DECC and SCC work together to ensure that flood management infrastructure maintains sufficient water levels in floodplain wetlands for ongoing habitat values, breeding of water birds and frogs etc.	Water levels in many floodplain wetlands have been maintained at artificially low levels to benefit floodplain agriculture, or to achieve high drainage rates after flood events. The aim of this action is to achieve a better balance between safety and efficiency objectives and ecological objectives.	Research is still required on the best water management regimes for many wetlands. Must be linked to discussion with landholders about water levels for viable pasture outside core wetland habitat.	Positive. High priority, in concert with other actions to enhance the ecological health of floodplain wetlands.

Table 9.1 – Structures, Land use and Biodiversity (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.4	Landholders adjacent to floodplain wetland reserves consider voluntary conservation measures for remnant habitat areas, to improve continuity.	This action is a mechanism by which other biodiversity actions may be achieved. Voluntary Conservation Agreements with DECC go with the title to the land and are designed to provide long term conservation management of high natural values on private property. There are advantages to landholders such as assistance with management plans, fencing etc.	Time required to explore voluntary conservation opportunities and resources within DECC to negotiate conservation packages that benefit landholders as well as provide positive ecological outcomes.	Positive. In conjunction with other incentives such as low interest loans, rate rebates or conservation offsets, voluntary conservation is an important way to shift the management of the floodplain towards ecological as well as productivity benefits. High priority.
9.5	Ensure that stock are excluded from Nature Reserves by suitable fencing (see also Tables 9.2 and 9.3). Grazing is not permitted in Nature Reserves.	This is the partner to Action 9.2 re minimising vehicle access. The intent is to manage core wetland areas and other pasture land with different priorities (objectives).	Cost of fencing and clear demarcation of boundaries. Land management plans required where loss of this grazing area presents a significant constraint to local landholders.	Positive. To be implemented in conjunction with other actions to enhance ecological values of the floodplain. High priority.
9.6	Exclude stock from the riparian zone by fencing or other measures (see also Table 9.2)	Whilst limited access of stock to the riparian zone may be acceptable, the aim of this action is to control stock access, removing additional stresses on unconsolidated bank materials and recovering riparian habitats. Exclusion of stock reduces threats to riparian vegetation restoration programs, contributes to good estuarine water quality and allows reed beds to recover. Will enhance recovery of habitat connectivity.	May be significant costs associated with fencing and provision of alternative water sources (particularly when combined with wetland exclusion). Preparation of property plans for each affected landholder would be necessary, so that productivity gains can be achieved as well as habitat gains.	Positive. To be implemented in conjunction with other measures in the riparian zone. High priority.

Table 9.1 – Structures, Land use and Biodiversity (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.7	Continue to implement ASS controls in Broughton Creek Hotspot area.	<p>Broughton Creek was the subject of research (Wollongong University and others) and investment through ASSMAC in the 1990s. It remains the highest acid sulfate risk in the region. Ongoing research and development of co-operative on the ground works to manage water levels etc, is intended here, including effluent reuse schemes, wetland habitat restoration, and achieving enhanced agricultural productivity.</p> <p>Maintain local ASS management group to facilitate program implementation and sharing of results.</p>	<p>Uncertainty about the effects of some management; requires close co-operation between DPI (Agriculture and Fisheries divisions), DECC, DWE, Council and landholders.</p>	<p>Positive. ASS has been a major biodiversity and productivity issue in Broughton creek for more than a decade.</p> <p>Ongoing high priority.</p>
9.8	Remove (or redesign) priority structures that block fish passage – implementing the priorities identified by DPI 2004 (see also Table 9.1).	<p>This is a key action from the SRCMA draft CAP. DPI has identified structures that are priorities for re-establishing fish passage.</p>	<p>Needs to be co-ordinated with other floodplain habitat works, (wetlands, water levels, drainage etc.).</p> <p>Must engage property owners in property planning and with assistance with investment in implementation of property plans with ecological benefits. SRCMA must be involved to assist with these property management plans.</p>	<p>Positive and high priority for the most important structures identified by DPI.</p>

Table 9.1 – Structures, Land use and Biodiversity (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.9	Include detailed assessment of habitat impacts in all assessments of proposed bank protection or flood mitigation structures (require as part of a DCP or guideline for land zoned 1, 6 or 7)	Where works are proposed under Part 5 of the EP&A Act, this assessment should be prepared by Council or SRCMA. The objective is to ensure that local as well as systemic habitat issues are addressed in the design of the structures, but also in deciding whether or not a structure is beneficial/appropriate for the specific location.	Timing depends on preparation of new integrated LEP and DCP for the Council area.	Positive. Moderate priority. Most applications would already require assessment of ecological impacts.
9.10	Prepare guidelines for sea walls and jetty designs for private waterfront properties – appropriate locations, materials and designs to minimise habitat and biodiversity impacts of construction. These should be reviewed when improved information about sea level rise and storminess become available, to ensure that risks are adequately addressed.	A relatively short length of the banks of the estuary is occupied by private residential waterfront. These properties are however in sensitive locations (e.g. seagrass beds near the shore) adjacent to oyster leases and in bays in the lower estuary where climate change impacts on nearshore habitats may be significant in the long term. This action aims to make property owners aware of the best design options to achieve practical private waterway access, maintain some public access wherever possible and provide appropriate protection from storm surges, etc., whilst minimising unnecessary biodiversity impacts.	Short term action is to update Council's wharves and jetties policy with information about walls and information for all types of structures about suitable design and materials. Will require consultation with property owners.	Positive in the long term. Low to moderate priority. Affects only a limited number of properties.

9.2 RESTORING THE RIPARIAN ZONE

Objectives:

To protect and restore the ecological diversity of locally indigenous riparian plant communities and habitats.

Protect and restore the connectivity of riparian and floodplain habitats.

Restoration of the riparian zone habitats of the Shoalhaven estuary is one of the most important objectives for the future health of the system. The objective applies to all management zones, regardless of their Principal Management Orientation.

Table 9.2 summarises the benefits and problems that may be associated with management actions for restoring the diversity and connectivity of the riparian zone along the estuary.

Table 9.2 - Restoring the Riparian Zone

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.11	<p>Develop voluntary conservation agreements with floodplain land owners to set aside riparian land for habitat restoration. See Sections 9.3.1 and 9.3.3 and Table 9.3.</p> <p>Property Vegetation Plans, formalised by agreements between the CMA and land owners are an alternative agreement by which land which is being managed for vegetation/habitat recovery can be recognised on a medium to long term basis (see Section 9.3.2).</p>	<p>Voluntary Conservation Agreements (Wildlife Refuges or more binding Voluntary Conservation Areas) are a mechanism which will facilitate other riparian zone actions, by redirecting the land management focus from production to conservation/rehabilitation. These agreements can be tailored for areas where habitat is actively recovering, or for land which has high conservation values.</p> <p>In conjunction with conservation management of floodplain wetlands, this mechanism could offer significant benefits for habitat continuity.</p>	<p>Not relevant to all estuary banks, so there may be an equity issue between landholders who would be involved in conservation and those who would not.</p> <p>Property management plans needed for all landholders who are involved in voluntary conservation. Property Vegetation Plans are a form of property management plan, and are prepared by the SRCMA for properties prepared to enter into agreements to provide certainty about clearing and conservation outcomes.</p>	Positive. High priority because these agreements will underpin management of critical sections of the estuary riparian zone.
9.12	Provide incentives for farmers to install off river water supplies for cattle and fence river banks to minimise cattle access to the riparian zone.	This is part of the property management that will assist farmers to redirect their land use focus away from the estuary banks. The incentives include various cost offsets, most likely developed through the CMA.	Program for floodplain incentives needs to be developed by CMA and be consistent with other land management incentives in the Authority area.	Positive. Medium priority, but part of the package of actions needed to improve the balance between productivity and conservation on the coastal floodplain.

Table 9.2 - Restoring the Riparian Zone (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.13	Provide incentives for farmers to replant/regenerate native species on unconsolidated alluvial banks (leave active point bars for ongoing sediment transport in the estuary). Focus on sections which are relatively stable (i.e. not affected by severe flood erosion, tidal current scour or wind wave erosion). See also Table 9.3 and Sections 9.3.1, 9.3.2 and 9.3.3 .	As above, the objective of floodplain management is to shift the balance more towards its biodiversity values, whilst maintaining the economic viability of floodplain agriculture. This requires productivity improvements from land that is not of very high conservation value. It also requires assistance to farmers to make the initial steps.	Costs to CMA or other organisations involved in providing assistance. Incentives may include preparation of property management plans (Vegetation Management Plans), offsets allowing more intensive use of non conservation areas, low cost loans for fencing and tree planting, support for community tree planting schemes.	Positive. As for most biodiversity actions, the net cost benefit depends on the extent to which biodiversity values respond to changed land management. Clearly there is some uncertainty attached to this, but integrated and focused management, such as making the floodplain the focus for funding for a period, is expected to yield positive results.
9.14	Continue to support riparian programs for reinstatement of reed beds and mangroves in the lower estuary, and reedbeds adjacent to floodplain pockets in the upper estuary.	The Shoalhaven community has demonstrated capacity to identify sites where bank management produces positive outcomes, and to implement the necessary planting works in conjunction with fencing etc. This is a major asset to the future management of the estuary.	Maintain community skills and leadership in this aspect of land management – ongoing assistance with training and materials.	Positive and an ongoing priority.

Table 9.2 - Restoring the Riparian Zone (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.15	Prepare and implement a Boating Management plan for the Shoalhaven River estuary. The Plan should address the contribution of boat generated waves to the loss of riparian vegetation (or reduced success of revegetation programs) in the upper estuary.	Bank erosion studies have shown that boat wakes contribute to (exacerbate) bank instability at certain sites, over and above the effects of flood scour, tidal currents or wind waves. This is primarily along straight protected reaches. Boat waves in these areas can attack the lower bank, causing undercutting of poorly consolidated materials. The process is most marked where riparian vegetation has been degraded.	Needs to be negotiated with waterway users. This is a significant issue for the Boating Management Plan for the estuary. Monitoring and compliance/enforcement are also problems in terms of resources and practicality (on river time by relevant agency officers).	Positive, in conjunction with other bank management measures. Moderate priority.
9.16	Control informal camping on the riverbank in the upper estuary – identify and manage suitable sites on public land. If large scale camping activities occur, require development consent for regular camping sites on private property (it would be possible to use the new Shoalhaven LEP to allow camping sites to be developed with consent in certain riparian zones).	Access to the upper estuary for passive recreational users is limited because most of the bank and adjacent land is in private ownership. This action implies both identification of suitable Crown land and negotiation with private landholders for vehicle right of way if necessary.	The objective of consent for development on private property is to improve regulation of waste management and waterfront structures where waterway users access the estuary through private land. Not a major issue at the moment.	Positive, but need is not urgent – will increase as the permanent population increases. Low to moderate priority

9.3 THREATENED SPECIES AND ENDANGERED ECOLOGICAL COMMUNITIES

Objectives:

Maintain and enhance the area and quality of seagrass habitat in the estuary.

Maintain the area of salt marsh community in the lower estuary.

Maintain and/or enhance the area of healthy floodplain wetland communities on the Shoalhaven coastal floodplain.

Maintain habitat for migratory wader species subject to International conservation agreements.

Table 9.3 summarises actions that are intended to maintain and protect Endangered Ecological Communities and habitat for threatened species along the estuary and across the coastal floodplain. These actions focus particularly on the protection and enhancement of habitat in floodplain wetlands, but also consider the management of habitat for visiting migratory waders in the lower estuary.

9.3.1 Voluntary conservation

The NPW Act provides for the establishment of conservation agreements and wildlife refuges on private property, as part of the “Conservation Partners Program.” Amongst other types of land suitable for this type of conservation management are lands which have high biodiversity values (natural habitats) or which have been restored to a standard where habitat and wildlife corridors are provided. Many rural landholders have entered agreements with DECC to manage part of their land for wildlife habitat or to protect native vegetation. DECC has also been working with industrial and mining land users to encourage protection of land with high conservation values in and around their activities.

Agricultural land users on the Shoalhaven floodplain could be considered in both categories – as guardians of remnant high conservation value habitats (EECs) and as managers of restored habitats (wetland and riparian).

When a landholder enters into a formal voluntary conservation agreement with DECC, the agreement is registered on the land title and continues with the title when the land is sold.

There are also incentives attached to these agreements. Land under an in perpetuity conservation agreement with DECC is exempt from local Council rates and may also attract other tax concessions. Conservation partners are also assisted with the preparation of land management plans and on the ground works.

Table 9.3 suggest voluntary conservation as an important opportunity for enhanced conservation management of the Shoalhaven floodplain.

Voluntary conservation opportunities can provide one part of a package of incentives that could encourage a change in land management around the Shoalhaven River estuary. The benefits would be enhanced if combined with action on floodgate management (for fish passage and to improve tidal ventilation) and habitat restoration programs. **Section 9.3.2** discusses a further possible incentive, through improved valuation of habitat in offset trading. The SRCMA co-ordinates a range of other incentives that assist and encourage land holders to manage their properties with sustainability of natural resources as an objective (see **Section 12.6**).

9.3.2 Property Vegetation Plans

DECC has developed a vegetation management system, administered by the SRCMA in the Shoalhaven, which is based on legal agreements under the *Native Vegetation Act (2003)* and the *Threatened Species Conservation Act (1995)*. Once signed, Property Vegetation Plans provide landholders with certainty for up to fifteen years about the suitability of parts of their property for clearing and ongoing agricultural uses. However, Property Vegetation Plans can also be used to obtain funding to protect and restore native vegetation. Some management actions that are linked to vegetation recovery, offsets and incentives may continue in perpetuity.

Property Vegetation Plans can have significant benefits for improving habitat connectivity. For instance, a Plan can apply over multiple adjoining properties, as long as all the landholders sign the agreement. These larger, joint Property Vegetation Plans may be more successful in attracting funding from the CMA for on the ground works, because of the greater conservation outcomes that they can deliver.

CMAs assist landholders to prepare Vegetation Management Plans, free of charge. The Plans are based on high resolution satellite imagery of the property.

9.3.3 Biodiversity offsets and incentives

Improved ecological community health and biodiversity is a key sustainability outcome for the Shoalhaven River estuary and floodplain. It requires significant shifts in land management. The NSW Government introduced the concept of Biodiversity Offsets in 2004 and a discussion paper on offset trading (biodiversity banking) was circulated in 2005 (DEC September 2005). The Government has proposed trials of the offset banking scheme in the Hunter and Far North Coast Regions. However, the concept would also appear to have good applicability in the Shoalhaven.

Parts of the Shoalhaven Council area have been identified for future growth in the draft South Coast Regional Strategy (DoP 2006). Ecological studies also clearly demonstrate that the floodplain and catchments around the estuary retain remnants of high biodiversity and have a high potential for biodiversity enhancement. Under the DECC proposal, the Shoalhaven estuary and floodplain areas could be classified as “red light area”, which could be targeted for restoration investment. Such areas could provide biodiversity offsets for development in other less sensitive localities (i.e. in this case, elsewhere in the lower Shoalhaven).

BioBanking legislation (a trading scheme for biodiversity offsets) was introduced to the NSW Parliament in mid 2006. Details of the assessment of potential biobank sites, allocation of credits and the operation of the trading scheme are still being resolved, and will be introduced as Regulations and guidelines. However, BioBanking is implemented as conservation management tool in all coastal areas, the trading of high conservation value offsets could provide a substantial incentive for floodplain landholders to change land management practices from grazing to conservation.

Table 9.3 of this Plan flags the concept of valuing and trading biodiversity offsets as a possible incentive option for floodplain landholders. If implemented, such a scheme would provide an incentive or “reward” for landholders to manage land for biodiversity values. For the community, such a system would help move significant areas into biodiversity management, outside of the formal reserve system.

The biodiversity banking scheme would need to be co-ordinated with other management actions, such as voluntary conservation agreements, and property management plans.

Table 9.3 – Protecting EECs and Threatened Species

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.17	Validate and remap floodplain and estuary EECs outside existing Nature Reserves, to assist with targeted restoration and protection actions.	Improve knowledge of the nature and condition of local EECs, so that focused conservation programs can be developed.	Cost and other resources within DECC and DPI.	Positive action, which will provide better baseline information about important vegetation communities. High priority, as outcomes will facilitate other actions.
9.18	Implement measures in floodplain Nature Reserve management plans to strengthen habitat and populations of the Green and Golden Bell frog	See Action 9.1 re implementation of Plans of Management for nature Reserves. This action reinforces the value of these habitats for the Green and Golden Bell Frog – they are identified as a major habitat area for the south coast.	Resource shortages at DECC combined with need to negotiate some actions with adjoining land holders.	Positive. High priority
9.19	Maintain regular mapping of aquatic habitat in the Shoalhaven River estuary (at 5-10 year intervals). This mapping should also indicate the extent of shoals that are valued habitat for migratory wader species.	Existing DPI mapping provides snapshots of the distribution of key aquatic habitats in the estuary. This is fundamental information for the EII and also for general community understanding of whether management is leading to good outcomes for the estuary.	Significant cost involved for field survey, analysis, preparation of maps and reports.	Low to medium priority – because of lead time to next mapping program (around 2010).

Table 9.3 – Protecting EECs and Threatened Species (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.20	Encourage land holders with saltmarsh communities on their property to enter voluntary conservation agreements providing for long term conservation management of the community.	Voluntary conservation is suggested as a key mechanism for achieving improved management of significant estuary habitats, currently managed for grazing.	The conservation agreement needs to be supported by a property management plan (Property Vegetation Plan) that assists the landholder to achieve improved productivity from areas of their property. Potential scale of voluntary conservation in the Shoalhaven would be resource intensive for DECC.	Positive. Commencing raising awareness about this mechanism is a high priority, but acknowledge that getting agreements in place is medium priority. Consider linking saltmarsh agreements and floodplain wetland agreements. Priority sites will depend on individual management circumstances, for instance willing landholders (one, rather than many across a given area of habitat or EEC), existing information, proximity to other conservation areas, etc.
9.21	Where saltmarsh communities are located on Crown Land, Plans of Management should refer to conservation management practices and minimise grazing access.	Saltmarsh is an EEC in NSW. The objective here is to ensure that all the management of all saltmarsh in Crown ownership contributes to the conservation of an important habitat. Some Crown land may also provide buffers around saltmarsh communities where retreat/migration is possible when sea level rises.	Resources to prepare and implement plans.	Moderate to high priority, but applies to only limited land (principally on Comerong Island, which is already subject to a Plan of Management for the Nature Reserve area).

Table 9.3 – Protecting EECs and Threatened Species (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.22	Review zoning of floodplain wetland areas to provide for environment protection outcomes. Council is preparing a new LEP over the next three years, as required by the NSW Government. New zones applied to the floodplain should reflect its environmental values.	This zoning is intended to protect wetland values – “intrinsic, scientific, scenic, habitat and educational”. All activities require development consent. The current zoning of some wetlands allows a wider range of uses, offering less protection.	Refer to wetland studies conducted by Council re boundary definition issues.	Medium to high priority. Consistent zoning for all wetlands will help establish a clear management direction.
9.23	Exclude cattle and cultivation from EEC along Regatta Creek (Swamp oak floodplain forest). Negotiate a conservation agreement and/or Property Vegetation Plan with the landholder(s).	This small area is restricted to the immediate vicinity of the creek and is surrounded by agricultural land. However, as habitat restoration works between Pig Island and Numbaa Island are also implemented, this existing habitat provides important connectivity.	Requires negotiation of conservation agreement with the land holder(s), including support/incentives for improved productivity outside the EEC.	Moderate to high priority – action should be commenced early to negotiate agreements with land holders that will facilitate a combination of other habitat restoration actions.
9.24	Exclude cattle and cultivation from EEC (Swamp oak floodplain forest) in Saltpan Swamp. Also address drainage and any ASS issued in this wetland. Negotiate a conservation agreement (under <i>NPW Act</i> and/or <i>Threatened Species Conservation Act 1995/Native Vegetation Act 2003</i> for the EEC and a buffer area, with the landholder(s).	Saltpan Swamp contains a larger area of habitat than Regatta Creek. It is similarly surrounded by grazing land and water levels are controlled by a floodgate. (note Saltpan Creek connects Crookhaven River back to Berrys Canal)	Rehabilitation of the wetland habitats around Saltpan Creek may require additional action on the floodgate – both from a tidal flow perspective and a fish passage perspective. Several floodgates in this area are listed by DPI (see Table 9.2 and Section 8.2.2). Action depends on negotiation with land holder about property management and incentives.	Moderate to high priority – action should be commenced early to negotiate agreements with land holders that will facilitate a combination of other habitat restoration actions.

Table 9.3 – Protecting EECs and Threatened Species (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.25	Negotiate voluntary conservation agreement(s) with landholders in relation to the EEC in Numbaa Swamp (River Flat Eucalypt forest on coastal floodplain).	This is a large area of floodplain habitat, away from the tidal channels.	As above, land use management will need to be integrated with floodgate management and zoning. Action depends on negotiation with land holder about property management plan and incentives for productivity gains outside the EEC.	Negotiation of voluntary conservation agreements is a high priority, as it underpins other management actions for the floodplain habitats.
9.26	Consider offset value of all voluntary conservation management on coastal floodplain – to provide incentive for landholders to manage EECs for conservation rather than agriculture.	<p>The Shoalhaven floodplain has major conservation potential. The wetlands could become valuable biodiversity offsets for other development in the area in the future (see Section 9.3.1), and this may provide financial incentives for landholders to move from agricultural to conservation land uses.</p> <p>A structured program of offset opportunities for new development would make conservation in priority areas much simpler for landholders.</p>	The Offset Trading Scheme has recently been launched (legislation passed), but details of Regulations and guidelines have yet to be finalised.	<p>Has potential to provide significant benefits, but the scheme is not ready for implementation as yet.</p> <p>Continued work on opportunities to encourage landholders to manage private land for conservation should be a high priority. Actual implementation of such schemes is likely to be at least a year away.</p>

Table 9.3 – Protecting EECs and Threatened Species (cont)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.27	Exclude cattle and cultivation from saltmarsh (EEC) areas on Bevan Island and Old Man Island. These areas have potential as “replacement” for areas lost to shoreline retreat and/or sea level rise (see also Table 8.6).	Bevan and Old Man Islands have double biodiversity potential. They contain recognised EEC habitat and could be part of an offset scheme in the Shoalhaven.	Loss of income for land holder; potential land acquisition costs.	Positive action – precautionary management of high value habitat. Negotiation about the management of these potential habitat migration areas should be commenced as a high priority, although full resolution of issues may take several years.
9.28	Identify conservation offsets for habitats that will be lost from Comerong Island and Nobles Island due to channel widening.	Saltmarsh is a valuable and vulnerable estuary habitat. As noted above, Bevan Island and Old Man Island may be suitable as offset areas, but further investigations may identify alternative habitat for long term conservation.	Suitable habitat may be fragmented and in diverse ownership, resulting in complex negotiation and management processes to place a sustainable parcel of saltmarsh into conservation management.	Positive action, with initial steps a high priority. Final components of negotiation may be delayed by negotiation processes and also by lack of clarity about how offset processes can be encouraged on private land (e.g. by the BioBanking scheme).

9.4 WATER QUALITY IMPACTS ON BIODIVERSITY: ACIDITY, SALINISATION AND NUTRIENTS

Objectives

Manage water quality variability within the range and rate of change that is suitable for protection of aquatic habitats in both the upper and lower estuary.

Provide a consistent approach to ASS across the Shoalhaven River, Crookhaven River and Broughton creek coastal floodplains.

Integrate ASS management with other aspects of floodplain management including agricultural productivity and habitat restoration.

Minimise/prevent ASS discharge events that significantly affect estuary water quality.

Manage water quality variability with the range and rate of change that is suitable for protection of aquatic habitats in the upper and lower estuary.

The Broughton Creek floodplain has been one of the State's acid sulfate "hotspots" for nearly a decade. Management of agriculture and habitat conservation in areas affected by acid sulfate soils requires careful co-ordination of floodgate management, inundation, discharges etc as well as selection of suitable land on floodplain properties for intensive agricultural uses.

Salinisation in the upper estuary occurs during extended periods of low flow. It is anticipated that saline conditions would become more frequent if sea level rises, and if climate change produces longer droughts. The actions discussed here are not intended to control these processes, but to manage risks to upper estuary habitats.

Removal of floodgates or modification of their operation will also encourage salinisation of tributary channels on the floodplain of the estuary.

At a whole of system scale, nutrient levels in the estuary vary with catchment runoff and tidal flows. Locally elevated nutrient levels can occur around the discharge points of specific pollution sources – urban stormwater and licensed discharges.

Actions to address the salinity, nutrient and acidity aspects of estuarine water quality are summarised in **Table 9.4**. There is considerable overlap between these responses and those to manage floodplain productivity, and enhance estuary biodiversity, reflecting the close association of these issues.

Table 9.4 - Water Quality Impacts on Biodiversity – pH, Salinity and Nutrients

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.29	Continue to implement actions to control ASS risks in the Broughton Creek catchment.	This is an important part of productivity management for farming lands. It should be implemented in concert with actions to remove blockages to fish passage and actions to maximise reuse of effluent. ASS in Broughton Creek catchment and elsewhere across the lower Shoalhaven is identified in the draft SRCMA CAP as a priority action for estuary health.	Time frames for effective assessment of the success of actions.	Positive action – moderate to high priority. Needs to be packaged with other biodiversity and land management actions in this catchment.
9.30	Implement the recommendations of the SCC (2006) review of ASS on the Crookhaven River floodplain.	ASS appears to present a lower risk to biodiversity and productivity on the Crookhaven River floodplain. As for Broughton creek, if ASS reduces productivity, it should be managed as part of an overall package of actions to enhance the conservation and production values of the floodplain.		Positive action, moderate priority.

Table 9.4 - Water Quality Impacts on Biodiversity – pH, Salinity and Nutrients (cont.)

Action number	Proposed management action	Likely benefits	Possible problems	Indicative cost/benefit and priority
9.31	Continue to seek effluent reuse opportunities for flows from wastewater treatment plants and industrial processing plants.	This relates mostly to Zone 8 (Broughton Creek) but also to other municipal wastewater treatment plants. The benefit is reduced water quality risks for recreational users and oyster growers, and will be most apparent during low flow periods.	Time and cost of negotiating agreements for reuse with landholders and implementing necessary controls (to meet consent and licence requirements).	Positive. Benefit also accrue in terms of demand for irrigation water, stock water etc, if appropriate water quality can be obtained. Moderate priority – part of integrated package of measures for floodplain management.
9.32	Include salinity in EII indicators for the Shoalhaven river estuary.	Salinity in the upper estuary varies with freshwater flows and tidal currents. Including regular salinity monitoring in EII (together with monitoring of aquatic invertebrates etc) would provide greater certainty about system variability and response processes.	Monitoring is a costly ongoing activity. Responsibility for costs to be negotiated.	Positive. Council already monitors salinity in the upper estuary; this action requires that monitoring is continued.
9.33	Require best practice management of urban stormwater for all new residential, commercial and industrial estates that drain to the estuary.	There is some evidence that stormwater affects estuarine water quality in the immediate vicinity of Nowra/Bomaderry urban areas. This action is directed at future growth – designs that minimise pollutant load. Ongoing vigilance is also required for existing potential sources such as waste facilities.	Potential additional costs for new development. Potentially limited opportunity to control runoff away from natural wetlands and the estuary.	Positive – should be a standard requirement of all urban rezoning and development programs. Moderate priority.

10.0 ACTIONS TO SAFEGUARD COMMUNITY VALUES AND ENJOYMENT OF THE ESTUARY

Community values incorporate cultural heritage, scenic landscapes, recreational opportunities, primary production values, employment and other economic benefits that derive from the natural resources of the estuary and opportunities for community participation in the management of the City's natural resources.

Tables 10.1 to 10.6 summarise the actions that are recommended in relation to these issues.

10.1 ABORIGINAL HERITAGE

Objectives:

Management of the estuary and coastal floodplain respects the values of the Aboriginal community of the Shoalhaven area.

Sensitive Aboriginal cultural landscapes are protected.

Local Aboriginal people have opportunities to participate in the management of the estuary.

Enhanced opportunities and support to encourage Aboriginal people to participate actively in the management of natural resources, building on their cultural traditions and practices for looking after country, are the first priority for protecting the Aboriginal heritage values of the estuary. By increasing the strategic and on the ground participation of local Aboriginal people, awareness and respect for the positive aspects of Aboriginal culture can be raised.

Associated with this participation objective are actions that protect the culturally sensitive landscapes of the Shoalhaven. This requires further consultation and implementation of the outcomes of the CCA Aboriginal cultural landscape projects, particularly by including references to Sensitive Aboriginal Cultural Landscapes in the objectives of environmental protection zoning and in development assessment requirements.

Proposed management actions are identified in **Table 10.1**.

10.2 NON INDIGENOUS CULTURAL HERITAGE

Relevant Objectives:

To protect significant heritage features and landscapes (vistas)

Two villages (Coolangatta and Terara) are listed in the Australian Heritage Database as significant elements of the cultural landscape of the Shoalhaven. The important house and former artist's residence at Bundanon, on the upper reaches of the Shoalhaven River estuary, are also listed. In addition to the National listings, several places are identified in the NSW National Trust Register. The Berry Landscape Conservation Area includes not only the floodplain and upper reaches of the estuary, but the escarpment and undulating coastal foothills. Several cemeteries, both aboriginal and early European are also listed by the NSW National Trust.

Whilst individual features are important, management actions here are focused on the overall landscape with which generations of Shoalhaven valley residents and visitors, including some of the country's most distinguished artists, have identified. Management actions are noted in **Table 10.2**.

10.3 RECREATIONAL ACCESS AND FACILITIES

Relevant Objectives:

Maintain diverse foreshore and water based recreational opportunities for residents and visitors, in keeping with the natural character of the estuary and recognising the potential for conflict between user groups with different values or needs.

Ensure the safety of water based recreational users.

Encourage tourism businesses that complement sustainable use of estuary natural resources.

Recreational opportunities on public land on the estuary foreshore are consistent with community lifestyle aspirations and with key ecological values.

Public access to the foreshore for recreational activities is maintained.

Estuarine water quality is maintained within the range that is consistent with oyster production/harvesting (particularly in summer), recreational swimming and boating (also most important in summer).

Maintain the visibility of the estuary from public land along the banks.

Recreational enjoyment of the estuary encompasses a range of water based activities (swimming, boating and fishing), but also includes walks along the waterfront, picnics and scenic outlooks from public reserves, roads etc. As noted in **Section 4**, these activities contribute to the local lifestyle, but also underpin an important part of the economy of the region.

Proposed management actions are identified in **Table 10.3**.

Table 10.1 - Actions to address Aboriginal Cultural Heritage Issues

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.1	Include protection of Aboriginal cultural heritage values as an objective of 7 zoning in the Shoalhaven LEP	Makes Aboriginal heritage a clear conservation priority for the City	Requires clear definition of the Aboriginal heritage values of the city – or for the estuary and floodplain in the current case.	Moderate – should follow the completion of the Aboriginal Heritage Study.
10.2	Provide opportunities for Aboriginal community involvement in the design and maintenance of foreshore reserve areas, such as at Nowra, Greenwell Point and Crookhaven Heads. This involvement could include public art, information boards that describe the cultural heritage of the estuary, and horticultural or other landscaping/maintenance tasks.	The Shoalhaven estuary has significant traditional and historical cultural value for Aboriginal people. Involving the local Aboriginal community in landscape design for public places builds on existing skills in the community and highlights positive aspects of culture.	Funding may be an issue. Requires time from council's Aboriginal community liaison/development officer.	Positive – excellent results can be achieved in showcasing local Aboriginal culture. Moderate priority – incorporate into redevelopment of major foreshore reserve facilities.
10.3	Complete a comprehensive Aboriginal Cultural Heritage Study for the Council area, which will place estuarine values in their overall landscape context. Review the Estuary Management Plan in the light of the Aboriginal cultural heritage study when it is complete, and modify Aboriginal heritage actions as necessary.	This project is under way. It will provide links between the Estuary Management Plan and the mapping of Sensitive Aboriginal Cultural Landscapes – highlighting landscapes (rather than individual sites) that should be protected.	Important to make this study directly relevant to the local Aboriginal community. Time and cost factors involved for appropriate level of consultation on potentially controversial issues.	Positive and ongoing. This document will facilitate other actions to enhance Aboriginal community participation in natural resource management.

Table 10.1 - Actions to address Indigenous Cultural Heritage Issues (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.4	Discuss with Aboriginal community leaders and existing representatives in catchment management planning/implementation, incentives or assistance needed to facilitate participation of Aboriginal community representatives in the SNRFMC.	The Aboriginal community is not currently directly involved in the SNRFMC, but representation in broader regional natural resource management planning has improved. This action will help to remove constraints to participation in the management of the estuary – Aboriginal people area significant group in the local community.	May need additional resources – for skill development, assistance to attend meetings etc.	Positive. This action reflects government policy – as expressed in Coastal Policy, and CAP.

Table 10.2 - Actions to Manage Non-Indigenous Cultural Heritage

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.5	<p>Complete a historic heritage strategy for the Shoalhaven Local Government Area.</p> <p>Review and modify the Estuary Management Plan as necessary in the light of the Historic (non Indigenous) heritage strategy that is completed.</p>	<p>The aim of this action is to diversify understanding and appreciation of the historic heritage values of the estuary and associated landscapes – not just buildings. Note that some Shoalhaven landscapes are listed in Register of National Estate.</p>	<p>Requires funding support from Heritage Office. The strategy would cover a much larger range of issues than the Shoalhaven estuary</p>	<p>Most buildings are already afforded some protection by their various heritage listings. This study would assist with broader conservation objectives and community identity. Low to moderate priority.</p>
10.6	<p>Restore riparian vegetation along the floodplain pockets in the upper estuary to maintain scenic amenity (see also Table 9.2 for habitat and bank stability benefits)</p>	<p>The upper estuary is the landscape context for important places such as Bundanon. It is also highly valued for passive recreation because of its scenic beauty. By stabilising high eroding banks and restoring riparian habitats, views from the water would be enhanced.</p>	<p>As for habitat restoration and bank erosion controls for other purposes, negotiation about conservation offsets will be important to engage landholders. Rezoning may also be necessary.</p>	<p>The intention of this action will be achieved if riparian vegetation communities are restored to meet other objectives (biodiversity and bank erosion).</p>
10.7	<p>Manage boating traffic in the upper estuary to control noise impacts on the natural landscape context of heritage sites (e.g. Bundanon). This will be addressed in the Shoalhaven Estuary Boating Management Plan.</p>	<p>This action is designed to contribute to the peacefulness value of the upper estuary landscapes.</p>	<p>May require negotiation about preferred power boating areas – safety issues, etc in other reaches.</p>	<p>Positive. This action is a consideration for the Boating Management Plan, which should be completed shortly.</p>

Table 10.2 - Actions to Manage Non-Indigenous Cultural Heritage (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.8	Prepare community information about the history of Berrys Canal and its continued morphological adjustment (see also Table 8.2).	The Estuary Management Plan follows the HRC recommendation that intervention in the morphology of Berrys Canal carries significant uncertainties and risks. The Canal is an important part of the heritage of the Shoalhaven, as well as demonstrating the long term response to seemingly minor structural controls.	May be community opposition to allowing erosion to continue.	This action needs to be implemented with others that recognise the value of the habitats along Berrys Canal – and provide offsets for losses (both from current erosion and from potential changes with sea level rise).

Table 10.3 - Options to Maintain and Enhance Recreational Access, Facilities and Enjoyment

Action number	Proposed management action	Likely Benefits	Potential Problems	Indicative cost/benefit and priority
10.9	Complete and implement a Boating Management Plan for the Shoalhaven River Estuary.	<p>The Boating Management Plan will bring together diverse measures to provide safe boating for a range of waterway users (from high speed to unpowered). It is expected to address the impact of boat wakes on bank stability and riparian vegetation, the interaction of ski boats and wake boards with people using the estuary for fishing or canoeing, as well as providing details on additional ramps, wharves etc.</p> <p>The upstream sections of Zone 1 are particularly attractive to passive recreational users, who value the vegetated banks and quiet, smooth conditions.</p> <p>Waves from boat wakes may be detrimental to both safety and amenity for these users.</p> <p>See also Table 10.2 re landscape benefits flowing from the Boating Management Plan.</p>	Funding for implementation and/or regulation may be issues.	The Plan is in preparation.
10.10	Improve public access for unpowered vessels (passive recreation) in the most upstream reaches of the upper estuary (i.e. identify where vehicle access is available on public river frontage land). See Action 10.9 .	<p>The Estuary Management Plan recognises the upper reaches of the estuary as providing important passive recreation values. This action proposes that vehicle access to the waterfront be provided in a few additional locations in the upper estuary to make the upper estuary more accessible for canoes etc.</p> <p>Boating access will be addressed in the Boating Management Plan (in preparation). See Action 10.9.</p>	May need regulation to maintain the focus on passive types of boating use.	This is not a high priority issue at the moment, but demand is expected to increase over time. The intent is to control potential over use impacts by creating specific well managed access locations. Low to moderate priority (although negotiation about sites is a higher priority).

Table 10.3 - Options to Maintain and Enhance Recreational Access, Facilities and Enjoyment (cont)

Action number	Proposed management action	Likely Benefits	Potential Problems	Indicative cost/benefit and priority
10.11	Identify public foreshore land along the river bank and potential water based access points and/or low key camping.	As above. The aim is to create controlled, low key camping opportunities at up to three locations.	Negotiation about access across private land (right of way, acquisition etc) may be complex and costly.	Positive, but low to medium priority. As above, commence negotiation as necessary to allow for these sites to be developed in the longer term.
10.12	Further develop Greys Beach Reserve as an Icon Park for the City (landscaping and visitor facilities) (see also Table 10.5).	The location of Greys Beach at the main river crossing point at Nowra/Bomaderry makes it attractive for through traffic as a picnic area as well as to local and visiting boat users. Improved pedestrian management, improved parking and improved visitor facilities will add to the attractiveness of the reserve. The aim is also to concentrate high visitor usage in relatively robust locations.	Significant vehicle and pedestrian access issues at this site, because of cliffs at back of reserve. Potential high costs for safe access and high quality facilities for large numbers of users.	Location of this reserve justifies expenditure. Positive action. Moderate priority –shortfall of facilities is not currently a major issue except for main holidays or events.
10.13	Improve boat launching facilities at Greenwell Point Ramp and adjacent reserve.	Webb McKeown 2003 recommended urgent work to control erosion along the Greenwell Point boat ramp reserve waterfront. Council has received funds from the Estuary Management Program for these bank protection works. The staged redevelopment of the ramp would include redesign and reconstruction of the ramp to improve efficiency and safety of launching, construction of a landing jetty (pontoon) and provision of further parking and landscaping (see below).	Overall cost of the works is estimated at \$600,00 (Webb McKeown 2003). Although half of this may be obtained from the Waterways Infrastructure Development Program and Asset Development and Management Program, the capital investment from Council is still large and the works may need to take place over several years.	Overall a positive action, especially in conjunction with Icon Park works. High Priority.

Table 10.3 - Options to Maintain and Enhance Recreational Access, Facilities and Enjoyment (cont)

Action number	Proposed management action	Likely Benefits	Potential Problems	Indicative cost/benefit and priority
10.14	Enhance Greenwell Point reserve as an Icon Park for locals and visitors. Prepare Master Plan and seek funding for implementation.	The combination of the Fisherman's Wharf, local fish outlets, boat launching ramp, visitor accommodation and picnic areas make the Greenwell Point Reserve a preferred site for development as a regional foreshore recreation area (SCC has identified these parks as "Icon Parks – SCC 2002).	Upgrade of the boat ramp is a high priority, with significant cost. Webb McKeown 2003 also recommends ongoing maintenance of the Fisherman's Wharf structure.	Positive Medium Priority
10.15	Provide temporary berthing for visiting vessels (recreational) at the old Greenwell Point Wharf (Anzac Park).	The permanently open entrance to the Shoalhaven estuary with reasonably safe navigation attracts cruising vessels. There are currently no facilities to accommodate these vessels so crew can access local services and tourism facilities. The Old Greenwell Point Wharf is close to the entrance and could be upgraded with limited investment (Webb McKeown 2003). Restoration of the sea wall at Anzac Park would also be required.	Cost of works and suitability of the wharf.	Low to moderate priority. This is a positive action for the longer term, and would be consistent with the overall development of Greenwell Point for recreation and aquatic primary production.
10.16	Improve public facilities at Cabbage Tree Reserve.	Provide alternative picnic facilities in most heavily used boating area.	Severe bank erosion along bank at Cabbage Tree Flat (outside of band). Strict controls on boat speed for approaching vessels would be necessary.	Low to moderate priority (see also Boating Management Plan).

Table 10.3 - Options to Maintain and Enhance Recreational Access, Facilities and Enjoyment (cont)

Action number	Proposed management action	Likely Benefits	Potential Problems	Indicative cost/benefit and priority
10.17	Landscape Crookhaven Heads/Orient Point ramp and reserve area and ensure facilities meet both local and visitor needs	The Crookhaven Heads facility provides a ramp, jetty and pontoon style water access, and is very popular with people wishing to fish outside the estuary. Current condition of the boating facilities is good but the landscape context would benefit from upgrading, to meet the needs of a wider range of visitors. The Plan suggests that the local Aboriginal community should have a role in the design of landscaping and signage.	Exposed and relatively remote site, so maintenance and vandalism may be issues. Highest usage is in main holiday periods.	Positive action, best implemented in the medium term.
10.18	Enhance connectivity of Nowra CBD to river bank	This action involves pedestrian walkways from the centre of Nowra, from other major parklands and along the river bank. This would link facilities such as the rowing and sailing clubs etc and would provide facilities for visitors at a high profile site – partnering the Greys Beach Reserve. This action is linked to actions for more formal bank stabilisation/interfaces in this area. As with other major reserve areas, the local Aboriginal community should have an opportunity to participate in landscape design. Note Council has received funds from the Estuary Management Program for bank protection works at the Rowing Club.	Significant cost for bank protection structures. Need to integrate landscaping and facilities for visitors with flood protection works along the urban parts of the estuary.	Positive, as a medium term action. Bank protection works are a first step.

Table 10.3 - Options to Maintain and Enhance Recreational Access, Facilities and Enjoyment (cont)

Action number	Proposed management action	Likely Benefits	Potential Problems	Indicative cost/benefit and priority
10.19	Manage boat speed and wash at locations where boat waves contribute significantly to bank instability (e.g. Mundamia Creek to Nowra Creek, right bank).	<p>Paterson Britton (2004) noted that Much of the bank erosion in the upper estuary is strongly influenced by flood scour. There are some sections however, where boat waves appear to contribute. These are high usage areas for powered recreational boating, where bank erosion may also be linked to visual quality, impacts on habitat restoration and navigation safety.</p> <p>Management controls will be addressed in a specific Boating Management Plan.</p>	Best controls to reduce risks of bank erosion need to be discussed with the recreational boating users re practicality.	A Boating Management Plan is in preparation.
10.20	<p>Prepare education material for waterway users about shallow water/rocks issues, particularly at low water/flow conditions.</p> <p>Focus distribution through ski clubs and the ski park.</p>	<p>Navigation safety in the upper estuary (Zone 1 in particular) is affected by exposed rocks and by shallow shoals, which may migrate during flood events. These present risks to vessels, particularly for people not familiar with the conditions in this estuary.</p> <p>This action is intended to complement other discussion and regulation of boating activity in the upper estuary.</p>	Identify best method for distribution of safety information. Could also be included in Boating Management Plan and highlighted in waterway maps.	Positive, moderate priority.

Table 10.3 - Options to Maintain and Enhance Recreational Access, Facilities and Enjoyment (cont)

Action number	Proposed management action	Likely Benefits	Potential Problems	Indicative cost/benefit and priority
10.21	Upgrade facilities for Nowra sailing club.	Located with the foreshore area for Nowra, which is recommended to be upgraded as a major visitor area. Details of needs of sailing club in terms of safe and practical access to the river to be further discussed with members.	Equity for other recreational clubs using the estuary.	Low to moderate priority.
10.22	Manage moorings for recreational vessels in the river to protect seagrass beds – establish guidelines and assessment requirements and identify areas where moorings will not be permitted.	Part of the approach required to protect the area of seagrass in the long term.	Availability of safe, non seagrass sites, particularly if existing mooring areas are a significant risk to important communities?	Whilst the principle of avoiding impacts on seagrass beds is important, there are currently relatively small numbers of moorings in the Shoalhaven estuary. Low priority, to be addressed as local population grows.
10.23	Restrict private foreshore structures (such as jetties and ramps) to existing use rights and encourage sharing of private structures and the use of public structures.	Reduces impacts of structures on foreshore/nearshore habitat. Reduces potential impacts on visual amenity in developed areas.	Negotiation of effective infrastructure sharing arrangements.	Positive. Moderate and ongoing priority.

10.4 ESTUARY AND FLOODPLAIN PRODUCTIVITY: AGRICULTURE, FISHING AND OYSTER INDUSTRIES

Objectives:

Estuarine water quality is maintained within the range that is consistent with oyster production/harvesting (particularly in summer), recreational swimming and boating (also most important in summer).

Water quality is consistent with healthy fishery habitat in all parts of the estuary.

Minimise the impacts of excessive nutrient or other pollutant loads on estuary health and productive activity by promoting reuse of industrial and municipal wastewater.

The estuary continues to support an ecologically and economically viable oyster industry.

Fish stocks are maintained at a level that is consistent with ongoing access to the fishery by Aboriginal, recreational and commercial fishers.

The productivity of the floodplain is maintained or enhanced, at the same time as the ecological values of the floodplain are protected or restored.

Promote an integrated approach to floodplain land use.

As noted in **Section 4.8**, the Shoalhaven River estuary is one of the few south coast estuaries where commercial fisheries still coexist with recreational fisheries. Commercial fishing in the estuary is regulated by Estuary General and Estuary Prawn Trawl Fishery Management Strategies. The intent is that in the long term the fishery productivity of the system is sufficient to support both commercial and recreational fishing without depleting fish stocks below sustainable levels.

The lower Shoalhaven/Crookhaven has also been identified (DPI 2006) as a key area for continuation of high quality oyster production.

The continuation of these values in the estuary depends not only on the regulation of demand (catch) but on the protection of water quality (essential for the oyster industry) and fishery habitat (separate from but related to biodiversity protection).

Table 10.4 summarises actions to maintain the productivity values of the estuary and associated coastal floodplain. These actions must be considered in association with the maintenance of estuary and floodplain biodiversity (see **Section 9**).

10.5 TOURISM AND URBAN DEVELOPMENT

Objectives:

Maintain and enhance the contribution of estuary based activities to employment and economic values in the tourism industry.

Protect outlooks and viewsheds of high visual quality throughout the estuary.

Urban development is concentrated at major centres.

Settlement in the estuary study area is currently concentrated in the Nowra-Bomaderry urban area and this will continue to be the case in the future. The draft South Coast Regional

Strategy proposes that most of the additional 26,000 dwellings expected to be required in the Shoalhaven over the next 25 years will be developed in accordance with the Nowra Bomaderry Structure Plan, the Jervis Bay Settlement Strategy and the Milton Ulladulla Structure Plan. Dispersal of settlement in small villages with limited services will not be encouraged.

The concentration of future development in the Nowra-Bomaderry area also reinforces the importance of effective urban stormwater management for the existing urban area and best practice stormwater management for all new areas. Stormwater from these towns drains either directly to the river, or to small local tributary creeks or to sensitive floodplain wetlands.

The importance of family visits was noted in **Section 4.7** as a reason for overnight stays in the Shoalhaven. If this situation continues into the future, the proposed growth of Nowra Bomaderry highlights the importance of quality visitor facilities and estuary foreshore access within the urban area. This raises the priority of the development of Greys Beach/The Grotto and the Nowra foreshore reserve area and also suggests that relatively formal interfaces with the river will be most sustainable for these parts of the foreshore.

In addition, the increasing local population and the ongoing popularity of Shoalhaven coastal villages (Shoalhaven Heads and Currarong/Orient Point in relation to the estuary) also highlight the importance of safe waterway access, quality visitor facilities and clear guidance for waterway and foreshore users in the lower estuary.

Table 10.5 summarises actions to manage the impact of urban growth pressures on estuary values.

10.6 COMMUNICATION AND PARTICIPATION

Objectives:

Ensure that the local community has an opportunity to be aware of estuary and floodplain management issues.

Ensure the local community has an opportunity to contribute to decisions about the future management of valued natural resources in the Shoalhaven estuary.

Provide ongoing opportunities and support for community engagement in implementing estuary management actions.

Provide incentives for community individuals/groups to take up sustainable management of floodplain and estuary properties.

Table 10.6 summarises actions to ensure that useful estuary management information is available in the community and that community interest groups have opportunities to be actively involved in the management of the estuary.

Table 10.4 - Actions for Estuary and Floodplain Productivity

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.24	<p>Protect oyster growing areas from water quality impacts (see draft NSW Oyster Industry Sustainable Aquaculture Strategy 2006):</p> <ul style="list-style-type: none"> • fence riparian zone to exclude cattle from the waterway near oyster growing areas; • restore riparian vegetation to filter agricultural runoff to the estuary and to provide a buffer between residential subdivision and oyster production areas; • minimise overflows or other discharges from sewage systems (storm events or maintenance); and • install water treatment systems, such as constructed wetlands on drains to the estuary from urban land, caravan parks etc in proximity to oyster production leases. 	<p>Shoalhaven identified as a high quality oyster production area to be maintained.</p> <p>Each of these actions recommended by the draft Sustainable Aquaculture Strategy is also recommended elsewhere in this Plan in its own right. For instance, restoration of riparian zone vegetation also enhances habitat connectivity and visual amenity and contributes to bank stabilisation (see Tables 8.1, 8.2 and 9.1, 9.2)</p>	<p>Riparian habitat protection/restoration for other purposes may not coincide with the priority areas to protect the quality of oyster production.</p> <p>Potential loss of productivity for floodplain landholders needs to be considered – see discussion of voluntary conservation and conservation offset policy in Section 9.</p>	<p>Negotiation of riparian zone management should commence as a high priority.</p>
10.25	<p>Manage recreational boating around oyster harvest leases. Details will be resolved through discussion between DPI and NSW Maritime about the interaction of the draft Sustainable aquaculture Strategy and the Shoalhaven River Estuary Boating Management Plan.</p>	<p>This is a recommendation of the draft Sustainable Aquaculture Strategy. Intent is to reduce risk of contamination of production leases.</p>	<p>Impacts of recreational fishing need to be further investigated – lease areas often regarded as good fishing spots.</p>	<p>Moderate priority</p>

Table 10.4 - Actions for Estuary and Floodplain Productivity (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.26	Prepare a climate change risk minimisation plan for the oyster industry, focusing on the effects of storm winds, rising water levels and increased numbers of extremely hot days. This will include shading strategies, measures to reduce wind damage to leases, continue change to floating infrastructure rather than racks.	See Table 8.6	See Table 8.6	See Table 8.6
10.27	Review partnership arrangements for funding of water quality testing in the estuary (Council, DPI and oyster growers).	Council and oyster growers conduct a range of monitoring in the estuary, to address various information needs and compliance requirements. There are multiple beneficiaries of monitoring of biological water quality, and this review would consider the most equitable cost distribution for the collection of this data.	Neither Council nor oyster growers have significant funds available for monitoring.	Monitoring of biological water quality is critical around oyster leases for marketing/QA reasons, and must be regarded as beneficial to the industry.
10.28	Ensure that oyster growers continue to be represented on the SNRFMC.	Oyster production is an important estuary use, with implications for other estuary users. Representation is important to ensure that these interactions can be fully discussed.	Availability of growers for meetings; balance of membership.	Positive and ongoing.

Table 10.4 - Actions for Estuary and Floodplain Productivity (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.29	Ensure that activities within oyster leases (e.g. waste stockpiles) do not encroach on adjoining Crown land that is managed for community benefit.	This is a housekeeping issue for oyster farmers. It affects both the impact of production areas on the health of the estuary and the ongoing public accessibility to Crown land (also clean up costs if waste is stockpiled on Crown land).	Inspection and regulation costs.	Positive and ongoing.
10.30	Amend the Shoalhaven LEP or other suitable planning instruments to include reference to the value of the oyster industry in the estuary and to require consideration of oyster aquaculture areas in development applications.	This action would require proponents to demonstrate that the impacts of proposals on oyster production leases are minimal (e.g. in relation to water quality).	May interact with tourism development in the lower estuary.	Positive, moderate priority.
10.31	Encourage fencing of grazing land on the floodplain that has frontage to the estuary, to minimise cattle access to the river – protection of aquatic and terrestrial river bank vegetation and water quality.	See Section 9 . Control of bacterial contamination of estuary waters in oyster growing areas reduces risks of health impacts and costs to growers for monitoring.	See Section 9 . Costs of fencing. Likely that fencing will need to be part of a Property Vegetation Plan or other Property Plan. Resource implications for SRCMA.	See Section 9 . Positive, moderate priority.

Table 10.4 - Actions for Estuary and Floodplain Productivity (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.32	Encourage and maintain co-operation between DECC and floodplain land managers about management of fire, feral animals, weeds and access to Nature Reserves.	This action highlights the importance of co-operative management of land management issues. The intent is to protect important habitat in Nature Reserves from edge effects. See also Section 9 – part of the implementation of Plans of Management for Nature Reserves.	Management of buffer areas may require negotiation of voluntary conservation, and assistance with property management plans.	Positive, ongoing priority.
10.33	Encourage land holders to enter into Voluntary Conservation Agreements with DECC where floodplain wetlands and EECs extend across their property from adjacent Nature Reserves. (see also Section 9), by offering offset or other incentives/assistance to achieve higher productivity (where appropriate) on other parts of their property.	This action aims to facilitate a consistent approach across floodplain wetland habitats, but also to assist and encourage landowners to maintain productivity from their agricultural activities. The voluntary conservation agreements will offer some incentives for landholders to manage those areas for conservation, but further support is likely to be necessary for the other parts of the properties (Property Vegetation Plans may assist here).	Landholders need to see benefits to productivity from the assistance/incentives that are provided. Costs of providing appropriate property management support for farmers – may be through multiple programs managed by different agencies.	Positive. Negotiation of voluntary conservation strategy for floodplain wetlands should be a high priority – to set direction for local actions. However, attention to incentives for productive use of non conservation lands is also a high priority, so that farmers are not unfairly disadvantaged by actions that are for broader regional or public benefit.

Table 10.5 - Tourism and Urban Development

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.34	Consider the potential for mosquito transmitted diseases in land use planning decisions – new or expanded urban areas should avoid proximity to breeding areas.	Increased risk of mosquito transmitted diseases has been recognised as a potential impact of climate change. Precautionary approach is to locate new development away from known mosquito breeding areas. Action to be implemented through detailed local settlement strategies in response to Regional Strategy.	Likely to be a long term issues and not immediately apparent.	Positive in the long term – planning decisions now affect potential risks in the future. Moderate priority.
10.35	Use appropriate zoning for floodplain areas that are not zoned 6, 7a, or 7b, to discourage further development of flood prone areas. Note that these zonings will all be reviewed during the preparation of the new Shoalhaven LEP, which will be completed within three years. Appropriate zoning to control development on flood prone land and to protect areas of high biodiversity value, should be applied.	The Shoalhaven floodplain is not suitable for urban or commercial/industrial development. The intent is to focus land use on agriculture, conservation and related tourism activities – not tourism developments.	The result is likely to be that development is concentrated around existing major centres – as proposed in Regional Strategy.	Moderate priority.
10.36	Focus urban development/expansion on non flood prone lands which do not drain directly to the estuary.	As above. The intent is to minimise the risks of urban runoff to water quality in the estuary. Innovative/effective water management systems will also contribute to this outcome.	Limits land that is suitable for urban growth – potential cost implications?	Moderate priority.

Table 10.5 - Tourism and Urban Development (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.37	Invest in quality recreational facilities (picnic areas, boat launching ramps, jetties and foreshore walks) at high profile foreshore reserves: Greys Point/The Grotto, Greenwell Point, Crookhaven Heads, Nowra urban foreshore (riverside walk) (see also Table 10.3).	See also Table 10.3 This investment is designed to achieve efficient delivery of high quality facilities at specific locations which are accessible and manageable for larger numbers of people – rather than local level facilities.	See Table 10.3 .	See Table 10.3 .
10.38	Approve low key camping accommodation with access to the upper estuary, to facilitate site(s) with appropriate environmental management.	See Table 10.3 .	See Table 10.3 .	See Table 10.3 .

Table 10.6 - Community Participation

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.39	Maintain support for the SNRFMC and other locality based natural resource management committees that provide advice to Council.	The SNRFMC is the key community forum for management of the estuary and offers links to Council's other natural resource management groups as well as to the SRCMA.	Ongoing administrative and project management costs for Council.	Positive and ongoing high priority as a communication measure.
10.40	Investigate options to encourage Aboriginal community participation in the SNRFMC and in on the ground works (see also Table 10.1).	See Table 10.1 re importance of Aboriginal cultural issues in the Shoalhaven.	See Table 10.1 .	See Table 10.1 .
10.41	Consistent, regular representation of government agencies and authorities (including the SRCMA) at SRNRFMC meetings and active participation in the implementation of the Estuary Management plan (see also Table 7.1).	The CMA is the regional organisation that determines funding priorities for natural resource management across the south coast. Important that the Authority actively participates with other organisations in the SRNRFMC to discuss the relative importance or and progress in implementing actions in the Shoalhaven estuary, to achieve regional natural resource objectives.	Resources for CMA and agency representatives to maintain regular and active participation.	Positive and ongoing high priority – communication should be a routine activity.

Table 10.6 - Community Participation (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.42	<p>Provide ongoing quality information to residents about the health of the estuary and the sustainability of management. Utilise local media with stories about estuary management actions, involvement opportunities and interpretation of monitoring results. Priority community information programs should include:</p> <ul style="list-style-type: none"> • boating management in the upper estuary; • managing the riparian zone – restoring habitat whilst maintaining productivity; • bank erosion and channel change in the Shoalhaven River estuary; and • floodplain wetland habitats – why they are important. 	<p>This action is both for community awareness and for positioning important issues. The suggested priority topics are all issues which are likely to be controversial and where the most sustainable response may not be the intuitive reaction of the community. Involve Council's media manager in developing the communication strategy.</p>	<p>Potential to add to controversy.</p>	<p>Positive. Intent is to provide objective information about how and why decisions have been made – and to add to community's capacity to participate constructively in decision making. Ongoing Priority.</p>
10.43	<p>Report progress in estuary management in Council's Annual Report.</p>	<p>Makes estuary management information readily available. Should include comments on major targets.</p>	<p>Co-ordination of reporting schedules.</p>	<p>Ongoing benefit. Ongoing Priority.</p>
10.44	<p>Support community involvement in the management of local foreshore and wetland reserves.</p>	<p>The Shoalhaven already has an excellent track record of community participation in natural resource management. This has significant benefits in terms of cost, commitment and ongoing maintenance of habitat enhancement.</p>	<p>Should not depend entirely on community based projects as these are all volunteers.</p>	<p>Ongoing benefit, provided there is also project support in Council and/or agencies. Ongoing Priority.</p>

Table 10.6 - Community Participation (cont)

Action number	Proposed management action	Likely benefits	Potential problems	Indicative cost/benefit and priority
10.45	Involve residents in qualitative monitoring of estuary condition, including photographic records of bank stability and revegetation programs.	Related to above action. Qualitative indicators are important to support quantitative monitoring, given variability of the system.	May be issues with consistency and maintaining the process in the long term.	Generally positive, moderate priority, depending on other forms of community involvement.
10.46	Continue to involve land holders in the implementation of acid sulfate management actions in the Broughton Creek floodplain area..	See also Table 9.4.	See Table 9.4.	See Table 9.4.

11.0 INTEGRATION OF ACTIONS BY MANAGEMENT ZONE

Sections 7 to 10 set out actions that are appropriate to address estuary management issues under each of the four major management themes. Details about each of the actions, including benefits and constraints, are provided in these sections. However, it is important to ensure not only that there is a consistent management approach within each major theme across the estuary as a whole, but that management actions are implemented in a co-ordinated manner in each part of the estuary.

Section 11 recognises that different parts of the Shoalhaven River estuary have different and distinctive values (see **Section 2**). As noted in **Section 2.5**, eight management reaches have been identified and in accordance with the specific values of these reaches, a Principal Management Orientation has been identified for each (**Section 2.5.4**).

Section 11 shows how the management actions and priorities fit together for each reach to provide an integrated program that is consistent with the Principal Management Orientation of each management reach.

11.1 MANAGEMENT REACH 1: BURRIER TO LONG POINT

This is the most upstream reach of the estuary and is most strongly affected by freshwater flows from the catchment (from small freshes to major floods). Tidal circulation is strongly attenuated and salinity may be reduced for extended periods after major runoff events. This section may also become quite saline and carry large numbers of jellyfish in extended warm dry periods. The channel is often bedrock controlled, with elevated pocket floodplain areas. Only the discontinuous floodplain areas are cleared and used for agriculture. The area has poor road access and the waterway is used primarily for low key recreational access. Visually, this reach is dominated by high vegetated ridges and spurs, with still waters. Baringella Reach and Long Reach are oriented close to east-west and are exposed to long periods of sunshine. Some landscapes in this management reach have significant cultural value.

The Principal Management Orientation (see **Section 2.5.4**) for this reach of the estuary is Comprehensive Protection to Significant Protection. This recognises the sensitivity of the area and its retention of important natural and visual values.

11.1.1 Sustainability Actions for this Zone

Actions for this zone focus on maintaining and enhancing the naturalness of the upper estuary.

The distribution and nature of these potential actions is shown in **Figure 11.1**. Details about the justification for each of these actions are provided in **Sections 7 to 10**.

- Restoration of riparian vegetation is encouraged for bank erosion control, enhanced habitat connectivity and improved views from the waterway.
- A Boating Management Plan should be released for further public consultation about appropriate management of the interaction of passive and active recreation as soon as possible.
- Improved access to public land bordering the estuary is recommended, for camping and picnics by day visitors.

- Conduct ecological studies/monitoring to provide reliable quantitative data about long term changes to water quality (salinity) and ecology (macro invertebrates, fish etc.), both as a result of modified environmental flow rules and due to climate variation or long term sea level rise.

11.2 MANAGEMENT ZONE 2: LONG POINT TO BOMADERRY CREEK JUNCTION

Like Zone 1, this zone is within the sandstone gorge country of the Shoalhaven River estuary. The high bedrock walls are a rare terrain type for an estuary in NSW. The meandering channel is bedrock controlled, with only small pockets of floodplain. This reach also contains significant development, including the Princes Highway Bridge, the urban areas of Nowra and Bomaderry, and relatively intensively used recreational waters. The management zone is favoured by ski boats, but also contains a sailing club, rowing club, fish outlets and foreshore based recreational uses. A major regional scale boat ramp and associated facilities are located at Greys Beach. Despite this relatively intense development and the potential for further growth of the urban areas, the management zone also retains significant areas of natural bushland (e.g. in The Grotto Reserve) as well as several important Aboriginal sites associated with rock shelters in the sandstone valley sides.

The Principal Management Orientation (see **Section 2.5.4**) for Management Zone 2 is Significant Protection (for the upstream parts of the reach, merging with Management Zone 1) and Healthy Modified (for the area around Nowra Bridge).

11.2.1 Sustainability actions for Zone 2

Actions balance the high recreational value and urban context of this part of the estuary with its high scenic beauty and naturalness.

Potential management actions for this zone are shown in **Figure 11.2**.

- High quality recreational facilities and more formal and robust recreational spaces, pathways, lookouts etc are recommended at Greys Beach, The Grotto and Nowra city foreshore, as well as for the shoreline at the Nowra Ski Park. These are all high profile recreational spaces and apart from the ski park, are in public ownership. The high priority recommendations of the Greys Beach and The Grotto Plan of Management should be implemented. These relate to improved pedestrian access and safety measures; improved parking and vehicle access to Greys Beach; more formalised walking paths and picnic facilities.
- Controlled high speed power boating is catered for in this reach, provided measures are in place to protect vulnerable banks from waves generated by boat wash. Boating activity will be formalised through a Boating Management Plan.
- Urban growth will continue in this part of the estuary (Nowra/Bomaderry Structure Plan and South Coast Regional Strategy). Development must recognise a range of potential constraints, including stormwater impacts on estuary water quality, sensitive nearby floodplain wetlands, mosquito breeding areas and sensitive Aboriginal cultural landscapes.
- Aboriginal people in the local community should have an opportunity to contribute cultural themes to the landscaping of high profile public spaces along the estuary.

11.3 MANAGEMENT REACH 3: SHOALHAVEN RIVER- BOMADERRY CREEK TO O'KEEFES POINT

This Management Zone is the main unconfined section of the Shoalhaven River estuary. A wide straight channel is set within an extensive floodplain. Pig Island, Numbaa Island, Regatta Island, Bevan Island and Old Man Island are large alluvial deposits in the channel, possibly only dating to the last 200 years. Channel adjustments around the islands have contributed to bank erosion.

The main floodplain is primarily used for agriculture, with only rural settlements, some of which are flood prone (e.g. Terara). Severe flood scour also contributes to bank erosion.

The floodplain and riparian zone have been almost completely cleared, but remnants of swamp forest remain within floodplain wetland areas. There are also small areas of estuarine fringe forest, estuarine creek bank scrub and mangrove forest.

The natural values of the estuary and floodplain in this management zone have been extensively modified. There is, however, potential to restore habitat values, particularly in floodplain wetlands and riparian communities. Fringe communities along the estuary banks are likely to be vulnerable to additional erosion impacts due to medium to long term sea level rise. There is still potential to restore riparian communities and aquatic communities adjacent to eroding banks, to help enhance habitat diversity and connectivity. The flood prone nature and high agricultural capability of the entire area largely precludes any intensive development.

Overall, the Principal Management Orientation (see **Section 2.5.4**) for this management zone is considered to be Healthy Modified.

11.3.1 Sustainable Management Actions for this Zone

Management focuses on restoration of critical riparian and wetland habitats, encouraging rural landholders to maximise conservation opportunities as well as maintaining productivity.

Management actions for this zone are shown in **Figure 11.3**.

- Fencing of wetland habitats to exclude cattle, ongoing drain management (including restoration of tidal ventilation) and voluntary conservation agreements are recommended. These actions will be targeted at remnant Endangered Ecological Communities (such as along old channels and in floodplain wetlands – Numbaa Swamp and Regatta Creek). The intent is both to enhance the health of these remnants and to improve connectivity between isolated habitat remnants.
- Further restoration of riparian habitat along parts of the main Shoalhaven Channel between Pig Island and Numbaa Island is recommended. Construction of rock revetments is generally not supported. Maintenance of existing walls and flood controls at Terara should continue, but further urban development at this location should be discouraged.
- Incentives should be available to assist landholders to modify property management. These include low cost loans, property management advice, assistance with preparation of conservation management plans for voluntary conservation areas etc. These measures would be co-ordinated through the SRCMA (e.g. riparian vegetation incentives program).

- The zone includes Bevan Island and Old Man Island. These are potential habitat offset areas for losses of aquatic and riparian vegetation (saltmarsh and mangrove) along Berrys Canal (Comerong Island). Options for managing these lands for conservation should be investigated.
- Exclude recreational boating from oyster harvest leases in the area to the north of Bevan Island, consistent with the DPI Sustainable Aquaculture Strategy.
- Sand extraction could occur at Pig Island, provided it does not create long term holes in the estuary bed and is consistent with sand supply from upstream. Any changes to sand extraction procedures should be informed by suitably detailed studies of sediment transport processes in the estuary.

11.4 MANAGEMENT REACH 4: O'KEEFES POINT TO SHOALHAVEN HEADS

The local scale morphology and water quality of this management zone are strongly influenced by marine processes. Shoalhaven Heads was once the main entrance to the estuary, but has been replaced by Crookhaven Heads. Bevan Island, Old Man Island and associated accreting sand shoals to the east and south east separate the entrance area from the remainder of the estuary. The shoal and entrance area provide habitat for migratory waders and large numbers of observations of protected species have been made in this area. DECC and Council are working co-operatively to protect shorebird habitat and populations in this area.

Severe bank erosion is occurring along the western shoreline of Comerong Island, opposite the shoals, but is probably driven by wind waves as the shoreline has extensive exposure to the west. The bank erosion is impacting on Endangered Ecological Communities, particularly Swamp Oak Floodplain Forest.

The sand barrier at Shoalhaven Heads is frequently closed to the ocean, with a high sand berm established. The Shoalhaven Heads Entrance Management Strategy is designed to allow artificial opening of the entrance when high water levels in the estuary threaten flooding of low lying property in the Shoalhaven Heads village.

The village contains a high proportion of holiday homes/units and caravan park accommodation. Recreational access to the estuary is available at several ramps and jetties. There are approximately 13 hectares of oyster leases in this part of the Shoalhaven River.

The Principal Management Orientation (see **Section 2.5.4**) for this zone is considered to be Significant Protection.

11.4.1 Sustainable Management Actions for this Zone

Manage for both conservation and recreation values, linking estuary and coast.

Management actions for this zone are shown in **Figure 11.4**.

- Restrict urban land use to within the existing zoned land at Shoalhaven Heads.
- Complete current studies to refine entrance management, floor levels and emergency response processes (flooding). The intent is that entrance management will continue to be based on the dry notch, with minimal other intervention.

- Restore mangrove habitat along the western margin of Comerong Island which is subject to long term retreat due to a combination of wind wave erosion and tidal current scour. It may be necessary to use wave baffles or to construct a rock wall at this location in the long term. Management must be consistent with the implementation of the Comerong Island Nature Reserve Plan of Management.
- Protect the productivity of oyster leases by implementing controls on urban stormwater and managing recreational boating through harvest lease areas.
- Minimise private foreshore structures and encourage the use of public ramps and jetties.
- Continue to support the co-operative partnership between DECC, Council and the local community for the protection of shorebird habitat and large populations that are present in the Shoalhaven Heads area. Predator control, exclusion of disturbance at sensitive times and enhanced community awareness are all part of this partnership.

11.5 MANAGEMENT REACH 5: O'KEEFES POINT AND BERRYS CANAL, COMERONG ISLAND AND APPLE ORCHARD ISLAND

Berrys Canal carries the entire tidal flow of the Shoalhaven estuary most of the time, at very high velocities. The channel has widened by 80 metres or more since it was originally excavated, but is still significantly undersized compared to the main channel of the Shoalhaven River immediately upstream. The bed and banks continue to adjust and are expected to be unstable for many years. Severe erosion on both sides of the Canal is impacting on Endangered Ecological Communities, particularly mangrove and estuary fringe forest on Comerong Island. Grazing land is also affected on the western side of the Canal.

It is likely that sea level rise will exacerbate existing erosion problems in this area.

The Principal Management Orientation (see **Section 2.5.4**) for this zone is considered to be Significant Protection.

11.5.1 Sustainable Management Actions for this Zone

Management will focus on protecting the very high conservation values of Comerong Island and associated islands, acknowledging that control of the morphological change along Berrys Canal is not feasible.

Management actions for this zone are shown in **Figure 11.5**.

- Implement the Comerong Island Nature Reserve Plan of Management, particularly in relation to access and migratory wader habitat.
- Allow Berrys Canal to continue to adjust (channel widening and deepening, high velocity currents), acknowledging that high quality habitat will continue to be affected.
- Include measures of the health and area of aquatic habitat and migratory wader habitat in the zone in the EII for the estuary, so that reliable quantitative data is available to evaluate future impacts of both bank erosion and sea level rise.
- Seek conservation management of offset habitat for saltmarsh and mangrove areas that will be removed by erosion. This requires identification of alternative representative habitat (potential areas are located on Bevan Island and Old Man Island, and the existing farmland on Comerong Island could also offer rehabilitation and conservation

opportunities, where it is not subject to severe erosion). Appropriate agreements will need to be developed with landholders to achieve long term conservation. Suitable offset areas must also have sufficient buffer land slightly above mean high tide to allow for retreat/migration of intertidal habitats, as sea level rises.

- Manage recreational boating around oyster leases to minimise risks to healthy oyster production.
- Minimise private foreshore structures and encourage the use of shared facilities, public launching ramps and jetties.

11.6 MANAGEMENT REACH 6: GREENWELL POINT TO CROOKHAVEN HEADS

This Management Zone is the most marine of all parts of the estuary, in terms of dominant processes, waterway productivity and recreational uses. The training wall at Crookhaven Heads ensures a permanently open entrance to the estuary, although there is some shoaling of marine sands (tidal delta) inside the entrance.

The villages of Greenwell Point and Orient Point are holiday and fishing centres, with a high proportion of unoccupied (holiday) accommodation. Major regional scale boat launching facilities are located at both Greenwell Point (in an Icon Park setting) and at Crookhaven Heads. The foreshore reserve at Greenwell Point is affected by bank erosion, and strong current velocities occur close to shore.

The lower Crookhaven River is the main focus of oyster growing in the estuary, with some 140 hectares of lease. Production from the Shoalhaven (Crookhaven) leases is the second highest on the south coast (although less than half the production from the Clyde River estuary; Merimbula and Wagonga estuaries produce similar amounts of oysters).

Orient Point and Crookhaven Heads have significant Aboriginal community values (Jerrinja people).

The Principal Management Orientation (see **Section 2.5.4**) for this zone is considered to be Significant Protection.

11.6.1 Sustainable Management Actions for this Zone

Management focuses on protecting estuary productivity and recreational/tourism values.

Management actions for this zone are shown in **Figure 11.6**.

- Restrict urban expansion at Greenwell Point and Orient Point to within the existing zoned area.
- Limit private foreshore structures and encourage the use of shared facilities, and public boat ramps and jetties.
- Install water quality controls on urban stormwater outlets in Curleys Bay.
- Review and update guidelines for structures on private waterfront land (primarily relevant to Greenwell Point). Guidelines will discuss suitable designs, materials and long term issues such as sea level rise.

- Implement the actions to enhance facilities and safety in the Greenwell Point Foreshore Reserve, to make it consistent with the concept of an Icon Park which meets the needs of tourists as well as local residents. These actions include improved launching facilities; works to control bank erosion and improve the safety of swimmers; temporary berthing for visiting recreational vessels at Anzac Park.
- Continue to monitor and improve the performance of the West Street slipway.
- Provide opportunities for local Aboriginal people to be involved in the landscape design for foreshore reserves.
- Manage recreational boating to protect water quality in oyster production leases.
- Establish clear protocols for communication with oyster growers about any planned or emergency maintenance works on the sewage reticulation system which may impact on water quality in and around oyster leases.
- Prepare climate change risk reduction guidelines for oyster growers, focusing on storminess and greater incidence of high temperature days.
- Upgrade the landscaping at the Crookhaven Heads/Orient Point boat ramp.
- Dredge shoals in the entrance channel at Crookhaven Heads only when channel markers and safety advice are not sufficient to provide safe navigation.
- Maintain records of algal blooms and phytoplankton in the lower estuary, as part of the EII for the system, and as an indicator of possible changes to water chemistry due to long term climate change.

11.7 MANAGEMENT REACH 7: CROOKHAVEN RIVER/CREEK AND FLOODPLAIN

The Crookhaven River and its estuarine floodplain occupy most of the southern part of the project area. Geomorphic evidence suggests that the old Crookhaven channel was once the main channel of the estuary, before it switched to the north and widened. As a result, the southern floodplain areas have a lower risk of acid sulfate soil issues than the Holocene and recent floodplain units associated with the Shoalhaven Channel and Broughton Creek.

The Crookhaven River floodplain has been extensively cleared and is used for dairying and horticulture, both valued land uses that have traditional associations with the area as well as attracting modern visitors.

Pyree Swamp, Brundee Swamp Nature Reserve and Saltwater Swamp Nature Reserve are all located on the floodplain of the Crookhaven River and contain regionally significant areas of Endangered Ecological Communities as well as diverse waterbird habitat. The Green and Golden Bell Frog and Australian Bittern, both listed as Threatened Species have been recorded in the floodplain wetlands, and the Crookhaven floodplain is regarded by DECC as “one of the most significant areas for the species (Green and Golden Bell Frog) in NSW.” (DEC 2006).

The Principal Management Orientation (see **Section 2.5.4**) for this zone is considered to be Significant Protection.

11.7.1 Sustainable Management Actions for this Zone

Management actions focus on improved floodplain ecological health whilst maintaining agricultural productivity.

Management actions for this zone are shown in **Figure 11.7**.

- Implement the Plan of Management for Brundee Swamp and Saltwater Swamp Nature Reserves. Key actions relate to stock exclusion, restricting vehicle access, fire management and habitat protection for the Green and Golden Bell Frog. Ongoing liaison with adjoining property owners to achieve consistent management of adjacent swamp and surrounding areas will be necessary.
- Review zoning of all floodplain wetlands and rezone to an appropriate environment protection zone under the new Shoalhaven LEP, which will be prepared over the next three years. Current relevant zones are 7(a) (Environment Protection – Ecology), 7(b) (Environment Protection - Estuarine Wetlands) (both under the Shoalhaven LEP 1985, as shown on Council’s web based mapping).
- Exclude cattle and vehicles from Pyree Swamp. Negotiate voluntary conservation of this area with land holders.
- Investigate options to improve tidal ventilation and remove blockages to fish passage, in accordance with priorities identified by DPI (2005). Key sites include Crookhaven River floodgate and floodgate to Pyree Swamp. Care is required in managing floodgates to ensure that salt water does not overtop drains and enter freshwater wetlands on the floodplain.
- Implement actions as necessary to address any acid sulfate issues for this floodplain area – generally not previously recognised, but see Shoalhaven City Council (2006) for possible risk areas.

11.8 MANAGEMENT REACH 8: BROUGHTON CREEK AND FLOODPLAIN

Broughton Creek and its floodplain occupy much of the northern part of the study area. The floodplain has been extensively cleared and is used for dairying. Floodplain drainage has also been extensively modified by drains and floodgate structures. In the 1990s, Broughton Creek was identified as an acid sulfate “hotspot” in the NSW acid sulfate program, with significant acid discharge events, fish kills and degradation of aquatic habitat.

Several projects have been implemented to reduce the incidence of acid events in this catchment area, including installation of “Smartgates” to allow some penetration of saltwater in the drainage system, and tilting weirs to help raise the water table. Lime injection has also been trialled as have wetland revegetation programs.

Berry STP, Bomaderry STP and regionally important processing industries (Shoalhaven Starch, Manildra Starch) are located in this Management Zone. Upgrades to sewage treatment and management, including increased reuse of effluent in floodplain irrigation are contributing to improvements in river health in this management zone.

Notwithstanding these improvements to management, this management zone is subject to significant impacts. The Principal Management Orientation (see **Section 2.5.4**) for the zone is considered to be Healthy Modified.

11.8.1 Sustainable Management Actions for this Zone

Management actions focus on maintaining agricultural productivity, with specific investment to reduce constraints to productivity and critical impacts on ecological health.

Management actions for this zone are shown in **Figure 11.8**.

- Continue to implement measures to minimise acid sulfate soil risks, which affect the productivity of both the floodplain and the estuary.
- Protect specific small remnant areas of Endangered Ecological Community in the lower reaches of Broughton Creek. Provide appropriate ecological incentives to land holders to assist with changes to management of these areas and to encourage improved habitat connectivity in the riparian zone.
- Remove priority blockages to fish passage, as recommended by DPI (e.g. culverts at Berry).
- Maximise opportunities for reuse of wastewater treatment and industrial effluent for pasture irrigation. Require stringent efficiency and quality controls on urban stormwater and industrial discharges, to minimise discharges of pollutants to the estuary.

PART 4: PLAN IMPLEMENTATION

12.0 IMPLEMENTATION STRATEGY

This section deals with the practicalities of implementation. It discusses the overall priority and packaging of actions, which organisations are responsible for various actions, and the other organisations that will need to contribute as active partners or technical advisors or for reporting purposes.

Tables 12.2, 12.3 and 12.4 provide this information for the highest priority individual actions, moderate priority actions and for ongoing individual actions. Each of these tables provides the following information:

- Action – what needs to be done.
- 5 Time frame – when should the actions be initiated. Some actions can be completed quickly; others will require several years of concerted effort, so finish times have not been specified.
- Why this action is important – this refers back to the information provided in **Section 11**.
- Relationship to other actions. As discussed in **Section 12.1**, significant efficiency gains and better environmental outcomes will be achieved if some actions are implemented as a package. These packages are spatially based (subcatchment areas) rather than program based.
- Who has primary responsibility for implementation.
- Other organisations involved and their roles.
- Indicative costing and sources of funds. Further information about the types of costs involved in sustainable management of the estuary and potential sources of funds is provided in **Sections 12.2 and 12.5**.

12.1 PACKAGING ACTIONS FOR IMPLEMENTATION EFFICIENCY

This is the final step of management integration for the estuary. The Management Plan adopts the principle that better environmental returns on investment are likely to be achieved if a suite of related actions is implemented concurrently (as much as this can be achieved within a two to three year period) in any management zone. This is particularly important for floodplain and riparian zone management actions, which seek benefits in biodiversity enhancement, and agricultural/aquatic productivity. In the upper estuary, actions to manage boating impacts should be implemented with actions to protect the riparian zone.

Table 12.1 summarises some important implementation packages for efficient estuary management. The priority order of these packages is influenced by the current level of risk across the major estuary management themes.

Some groups of actions which apply to the entire estuary, predominantly in relation to planning or communication should also be implemented as an integrated package. Examples include actions to enhance the participation of members of the local Aboriginal community in natural resource management; zoning of conservation lands; and communication between

Council, local residents and State government agencies about management issues, decisions and progress. These groups of actions are also noted in **Table 12.1**.

Some actions are uniquely important, and should be implemented according to their individual priority. For instance, whilst foreshore protection works and recreational facilities should be managed together at Greenwell Point, it is not essential to link these directly with actions to protect the viability of the oyster industry, or with flood protection measures for low lying land at Greenwell Point.

Table 12.1 - Management Integration

Suggested Priority	Management Zone	Actions to be implemented together
High	Zone 6 – Crookhaven River and floodplain	<p>Implement Plans of Management for existing wetland Nature Reserves.</p> <p>Remove DPI priority fish passage blockages.</p> <p>Assist landholders to prepare Property Management Plans to maintain productivity and enhance habitat quality and connectivity.</p> <p>Negotiate voluntary conservation agreements with landholders re buffers around wetlands, exclusion of cattle from wetland areas, exclude recreational vehicles etc.</p> <p>Rezone wetlands to an appropriate environment protection zoning to protect ecological values as necessary.</p> <p>Negotiate offset benefits (if this policy is adopted by the government).</p>
High	Zone 3 - Main Shoalhaven estuary channel	<p>Restore riparian habitats and floodplain wetlands.</p> <p>Property management plans for landholders to maintain productivity and allow enhanced habitat connectivity.</p> <p>Negotiate voluntary conservation agreements with landholders for cattle management on banks, exclusion from wetlands, fencing etc.</p> <p>Rezone wetland and river bank to an appropriate environment protection zoning to protect ecological values as necessary.</p> <p>Maintain structural bank protection where necessary to protect urban property (Terara)</p> <p>Negotiate offset benefits if this policy is adopted by the government.</p> <p>Investigate potential saltmarsh migration and/or offset areas and negotiate conservation management (private buffers, Crown Reserves etc)</p>
Moderate	Zone 1 – upper estuary and part Zone 2	<p>Complete and implement the Shoalhaven River Estuary Boating Management Plan, providing guidance about the interaction of active and passive recreational users of the upper estuary and impacts of boating activity on the riparian zone.</p> <p>Maintain scenic view corridors in upper estuary.</p> <p>Provide additional low key river access in upper estuary.</p> <p>Restore riparian vegetation around the margins of pocket floodplains – minor to moderate erosion, particularly where boat wakes exacerbate instability.</p>

Table 12.1 - Management Integration (cont)

Suggested Priority	Management Zone	Actions to be implemented together
High	Zone 8 – Broughton Creek	<p>Remove DPI priority blockages to fish passage.</p> <p>Continue actions to control ASS impacts.</p> <p>Maximise opportunities for effluent reuse/irrigation.</p> <p>Assistance landholders with property management plans to maintain productivity and enhance habitat quality and connectivity.</p> <p>Stormwater controls for new development (Bomaderry).</p> <p>Protect remnants of EECs on floodplain.</p>
High	Whole estuary	<p>Investigate and negotiate opportunities to introduce voluntary conservation agreements over key habitat areas across the floodplain and riparian zone – this applies to multiple remnant EECs and to priority areas for riparian habitat restoration. Buffer areas around existing nature reserves should also be considered for voluntary conservation.</p> <p>Investigate and refine localities where there is potential for landward migration of intertidal communities (particularly salt marsh).</p> <p>Place these habitat migration buffers in voluntary conservation management.</p> <p>Review Plans of Management for Crown Land or DECC land to ensure that conservation management applies to these buffer areas.</p> <p>Review zoning of floodplain wetlands and change to Environmental Protection (or similar appropriate zoning under the new LEP) as voluntary conservation is negotiated.</p> <p>Investigate/trial offset trading in the Shoalhaven, as the process is refined.</p> <p>Remove priority blockages to fish passage and tidal ventilation.</p>
High	Whole of estuary	<p>Complete Aboriginal Heritage Management strategy for Shoalhaven City Council.</p> <p>Liaise with Aboriginal community leaders about opportunities/incentives to encourage local Aboriginal people to participate in the SNRFMC.</p> <p>Liaise with the local Aboriginal community about opportunities to contribute to the landscape design and interpretation materials at significant foreshore reserves, particularly when they are known to be in a highly valued cultural landscape.</p> <p>Include protection of Aboriginal cultural landscapes as an objective of Environmental Protection zoning.</p>

Table 12.1 - Management Integration (cont)

Suggested Priority	Management Zone	Actions to be implemented together
High/ ongoing	Whole of estuary	<p>Ensure that the SRCMA is fully briefed on the priorities of the Shoalhaven River Estuary Management Plan.</p> <p>Liaise and negotiate appropriate indicators for the EII and responsibilities for integrated monitoring and reporting (including SCA, CMA, DECC, DPI, DWE, Council and community/business).</p> <p>Report on progress in estuary management in Council's Annual Report and in the CMA Annual Report.</p> <p>Support the ongoing operation of SNRFMC and ongoing representation of major local industry and community groups.</p> <p>Provide ongoing support to local environmental groups that participate in on the ground works (such as riparian vegetation restoration) and monitoring.</p> <p>Prepare community information on major issues, to clarify decision making processes and explain how management will proceed.</p>

12.2 SCHEDULE OF HIGHEST PRIORITY ACTIONS

Table 12.2 summarises responsibility and funding issues for the highest priority actions. Priority is based on the analysis presented in **Sections 7 to 10**.

**** INSERT IMPLEMENTATION TABLE FROM R02_Estuary Mangement Plan_V4 implementation table.doc ****

12.3 PARTNERSHIPS FOR PROGRESS

Shoalhaven Council has been proactive in managing the natural resources of the City and in building partnerships with other organisations that share responsibility for the protection or restoration of the City's natural resources. For instance, Council's Shoalhaven Natural Resource Management Committees include representatives of the SRCMA, DPI, DWE and DECC, all major players in the management of the water quality, biodiversity, cultural heritage and economic aspects of sustainable natural resource management.

Table 12.5 highlights the actions from **Table 12.2** (highest priority actions) that are Council's primary responsibility.

Table 12.5 - Council's highest priority actions

Action number	Action	Indicative investment
	Policy, Planning and Communication	
7.5	Report implementation of estuary management actions in Council's annual report	No additional investment required
7.8	Review Environmental Protection Zoning in the Shoalhaven LEP and associated DCP requirements to ensure that they reflect significant estuary values and threats.	Likely to be incorporated in a full review of the Shoalhaven LEP to bring it into line with new state requirements.
7.9	Develop protocols for communication/early warning to key stakeholders about estuary works that may impact on other sensitive values (e.g. sewerage system maintenance).	No additional investment required.
8.3	Complete floodplain management plan and implement priority actions (integrated with the Estuary Management Plan).	No further investment to complete the Plan. Significant investment for implementation (see also measures for sustainable coastal floodplain management in this Estuary Management Plan).
8.4	Review the Entrance Management Policy for Shoalhaven Heads at regular intervals, to ensure best available information about sea level rise and flood events is taken into account.	No additional investment required (within role of existing staff).
8.33	Include information about sea level change in Council's SoE	No additional investment required.
10.4	Discuss with Aboriginal community leaders and existing representatives in catchment management, incentives or assistance to facilitate Aboriginal community participation in estuary management.	Allow up to \$10,000 for initial awareness/liaison activities.
	Community values and enjoyment of the estuary	
8.21	Construct groynes or other structures to maintain the recreational foreshore (beach and nearshore) at specific sites.	Estimated cost of \$250,000 for Greenwell Point.
10.13	Improve boat launching facilities at Greenwell Point and the adjacent reserve.	Estimated cost is \$350,000 (Webb McKeown 2003)

Other high priority actions for which Council has a consultation or support role include:

- development of a practical EII and baseline data for the estuary (Action 7.4);
- various actions associated with protection or restoration of the riparian zone in rural lands (such as fencing, replanting) (Actions 8.28, 9.9, 9.14);

- discussions and subsequent negotiation of voluntary conservation agreements for high conservation value lands along the estuary (for instance, Council may consider rate relief for properties managing the estuary banks for conservation, where there are remnants of EEC) (Actions 9.11, 9.12, 9.13 and 9.14);
- development and implementation of incentives for off stream watering of cattle, to minimise cattle access down the banks and encourage rehabilitation of riparian vegetation; (Action 9.12); and
- implementation of the Plans of Management for Nature reserves (such as Brundee Swamp and Saltwater Swamp), by consistent management/regulation of adjacent land.

Table 12.6 summarises the moderate priority actions that are Council's primary responsibility.

Table 12.6 - Council's responsibilities for moderate priority actions

Action number	Action	Indicative investment
	Policy, Planning and Communication	
8.8	Prepare and communicate an emergency response plan for low lying areas of Shoalhaven Heads village (part of implementation of Floodplain management plan and Entrance Management Strategy)	Allow \$40,000; Scope and cost dependent on the final outcomes of the Floodplain Management Plan.
8.15	Ensure that all estuary banks outside existing urban areas are zoned to exclude intensive development of high hazard areas.	No additional investment required – part of overall review of LEP.
8.16	Identify reaches where erosion near existing infrastructure/services requires monitoring so that retreat can be effectively planned where necessary.	No additional investment required at this time.
8.36	Review zoning of land that may be affected by tidal or storm inundation and ensure appropriate planning controls continue to be in place.	No additional investment required – part of overall review of LEP.
9.9	Require detailed assessment of habitat impacts in all assessments of proposed bank protection or flood mitigation works.	No additional investment required.
9.22	Review zoning of floodplain wetlands to highlight conservation values.	No additional investment required, part of overall review of LEP.
9.31	Continue to seek effluent reuse opportunities for lows from wastewater treatment plants and industrial processing plants.	Allow approximately \$60,000 for investigations and feasibility studies.
9.33	Require best practice management of urban stormwater for all new residential, commercial and industrial estates that drain to the estuary.	No additional investment required by Council.
10.1	Include protection of Aboriginal cultural heritage as an objective of 7 (Environmental Protection) zoning in the Shoalhaven LEP.	No additional investment required (part of overall review of LEP).
10.32	Amend Shoalhaven LEP to include reference to the value of the oyster industry and to require consideration of oyster aquaculture areas in development applications.	No additional investment beyond that required for full review and upgrade of Shoalhaven LEP.
10.37	Maintain 1g zoning for floodplain areas (not zoned for conservation), to discourage intensive development.	As above.

Table 12.6 - Council's responsibilities for moderate priority actions (cont)

Action number	Action	Indicative investment
	Policy, Planning and Communication	
10.38	Focus urban development/expansion on non flood prone areas that do not drain directly to the estuary.	No additional investment beyond finalisation of Regional Strategy.
	Community values and enjoyment of the estuary	
8.31	Maintain structural controls on sections of bank (high profile, high usage and high risk recreational; foreshore areas) – e.g. Nowra foreshore, Greys Reserve.	Cost depends on design, materials and availability, length of bank to be treated. Indicative allowance of up to \$500,000 over five years.
10.2	Provide opportunities for Aboriginal community involvement in the design and maintenance of foreshore reserve areas – public art, information/story boards, landscaping etc.	Will depend on individual projects, but should not significantly increase costs above those already involved for landscaping and information
10.10	Improve community access for unpowered vessels (passive recreation) and regulated camping access in the upper estuary	Allow \$25,000 for investigation of opportunities.
10.11	Identify public foreshore land with potential for access from the water for small craft (complements above).	As above, but will need subsequent investment in ramps, jetties etc., potentially up to \$150,000.
10.12	Further develop Greys Beach Reserve and Icon Park for the City (landscaping and visitor facilities).	Allow \$250,000 as an indicative investment.
10.16	Improve facilities at Cabbage Tree Reserve.	Allow \$50,000.
10.18	Enhance connectivity of Nowra CBD to river bank.	Allow \$150,000

Council also has multiple support roles in relation to moderate priority actions.

12.4 FUNDING OPPORTUNITIES

Funds for the implementation of the Estuary Management Plan are available from a range of local, State and Commonwealth sources. Most funding programs involve competition for investment with other projects in the region or across the state – including other catchment based activities as well as coast and estuary activities. Matching funding applications to the key objectives of each program is critical.

Potential sources of implementation funds include the following:

- DECC programs, such as the Estuary Management Program, Coastline Management Program and Floodplain Management Program. DECC has also supervised a project officer position (funded by the SRCMA) to review potential EII indicators for the south coast.
- Department of Lands – Minor Ports Program. The program provides the commercial fishing and recreational boating industries with well-maintained port infrastructure facilities as well as safe, secure port access. This involves constructing and maintaining wharves, jetties, moorings and associated port facilities in keeping with the current needs of the NSW commercial fishing fleet. The upgrading of ports and port services has streamlined commercial fish handling.

- Council rates. Shoalhaven Council regularly invests part of its available revenue in various aspects of natural resource management. There is some potential to vary the relative investment in natural resources and Council's other responsibilities. Some Councils have also established a special levy to facilitate implementation of important natural resource management programs. A levy is not currently proposed to fund estuary works in the Shoalhaven River estuary, but this could be an option in the future.
- SRCMA – Estuary and Coastal Lakes Incentives Program – principally for high priority issues identified in an Estuary Management Plan. It is important to note that the Shoalhaven Estuary Management Plan is one of many within the south coast region. The sensitivity of coastal lakes has attracted significant project investment over the last five to ten years. The fund has previously invested in materials for bank protection works and project officers.
- SRCMA Dairy Industry Partnership Program. This program, which is a partnership between SRCMA, DPI, dairy farmers and the National Landcare Program, is intended to assist farmers to better manage nutrients, sediments, acid sulfate soils, pest plant species, riparian zone and water access, and pasture quality.
- SRCMA Revive Southern Wetlands Program. The program is currently focused on four coastal wetlands, including Coomonderry Swamp on the margins of the Shoalhaven estuary/floodplain.
- SRCMA Acid Sulfate Soils. The CMA is currently implementing an investigation program to better understand acid flows in the Shoalhaven and Crookhaven floodplains.
- SRCMA – Biodiversity Incentives. The CMA also has separate programs for activities that may be relevant to estuary health – such as road sealing. The CAP includes specific programs for *Caulerpa taxifolia* and removal of blockages to fish passage (part of the Bring Back the Fish Program).
- SRCMA Community Support Program. This program funds the employment of liaison, support and extension officers to work with local communities, building skills and capacity and ensuring that achievements are recognised and celebrated. This program includes an Aboriginal Community Support Officer.
- SRCMA *Caulerpa taxifolia* program, focusing on early detection of infestations.
- NSW Maritime Waterways Asset Development and Management Program (WADAMP). This program provides new and improved boat ramps, wharves, jetties, pontoons, dinghy storage, public moorings and vessel waste pump-out facilities. WADAMP provides up to 50 per cent of the value of each project in partnership with councils and community groups. Since NSW Maritime began this funding program in 1998, grants have been awarded to almost 200 boating infrastructure projects across the State, worth more than \$20 million. NSW Maritime received a total of 80 applications for WADAMP funding for projects in 2005-2006, with funding requests in excess of \$3 million.
- DPI Recreational Fishing Grants. All money raised by the NSW Recreational Fishing Fee is placed into the Recreational Fishing Trusts and spent on improving recreational fishing in NSW. These trusts are regulated by law and overseen by two committees made up of recreational fishers - one for saltwater and one for freshwater.
- Commonwealth Community Water Funds (Natural Heritage Trust).

- Commonwealth Community Envirofund (Natural Heritage Trust).
- Commonwealth Recreational Fishing Grants. The Programme seeks to assist recreational fishers to contribute to responsible and sustainable use of fishery resources, including helping to maintain fish habitat. Funding of up to \$100,000 (GST inclusive) is available. Within a three year program. Applicants are also asked to contribute, generally, on a dollar for dollar matching basis. In-kind contributions are acceptable.

The Program will invest in a broad range of activities, including the following areas as they relate to recreational fishing:

- (a) improvements to infrastructure, including establishing fish cleaning tables, boat wash down facilities and upgrading tracks and paths used by recreational fishers to access fishing spots;
 - (b) support of local initiatives to enhance recreational fishing, such as restocking or resnagging waterways;
 - (c) to protect the environment at the water's edge by, for example, protecting sensitive habitats;
 - (d) to establish and upgrade volunteer marine rescue groups and associated infrastructure;
 - (e) for education and awareness raising projects such as biofouling, aquatic pest translocation, increasing survival rates of released fish, and sensitive species; and
 - (f) to increase the capacity of local recreational fishing groups and communities through activities such as monitoring programs, tagging projects and data collection.
- Commonwealth natural disaster mitigation funds. A wide range of natural disaster mitigation works, measures and related activities qualify for funding under the Natural Disaster Mitigation Program. These include:
 - natural disaster risk management studies,
 - disaster mitigation strategies,
 - disaster warning systems,
 - community awareness and readiness measures,
 - land and building purchase schemes in high risk areas,
 - investment in disaster resilient public infrastructure, and
 - structural works to protect against damage (e.g., cyclone shelters, flood levees and retarding basins, bushfire asset protection zones).
 - National Landcare Program (NLP) (Australian Department of Agriculture, Fisheries and Forestry). The NLP encourages landholders to undertake landcare and related conservation works by supporting collective action by communities to sustainably manage the environment and natural resources.
 - NSW Environmental Trust Fund (administered by [DECC](#)). The Trust offered seven grants programs in 2006/07 totalling \$5.65 million. Funds are available for environmental education, research, school programs and restoration and rehabilitation conducted by community groups and government.

12.5 REVIEW OF PROGRESS AND PLAN UPDATES

The Shoalhaven River Estuary Management Plan is an important component of sustainable natural resource management in the Southern rivers Catchment Management Authority region.

One of the key underlying assumptions of the Estuary Management Plan is that the natural processes operating in the estuary are not static; in fact this is a very dynamic and variable natural system. In addition to changes to the nature and intensity of natural processes over time, it is anticipated that some community values (and certainly the priority given to some values) will change over time. Government policies affecting the implementation of the Plan will also evolve. For these reasons, it is important that the Estuary Management Plan is reviewed from time to time.

Reviews of the Plan should include three components:

- An audit style review of the extent to which proposed actions has been implemented. An example of this component of the review process is the audits conducted by the Healthy Rivers Commission of implementation of the Shoalhaven Statement of Commitment by State agencies.
- A review of estuary and floodplain condition. This will refer back to the EII assessment prepared by the National Land and Water Resources Commission, but will be based on a new a practical suite of indicators developed during current SRCMA benchmarking projects. The condition of the estuary is fundamental information to assess whether management is sustainable.
- A review of the continuing relevance of actions contained in the plan. This will include consideration of new policy directions, changing community preferences etc.

The outcome of these three components will be an amended or adapted Estuary Management Plan with new or confirmed priorities for the upcoming five to ten years. Ideally, the schedule for review and update of the Estuary Management Plan should be consistent with similar program reviews within the SRCMA. For instance, if the SRCMA benchmarking project results in a five yearly assessment of estuary condition, a full review of the implementation and success of estuary management actions at five yearly intervals would complement the condition assessment. Because the Estuary Management Plan process is managed by Council, the review timeframes must also meet Council's reporting needs. Actual timeframes for these reviews of the Estuary Management Plan need to be confirmed within the region.

All future reviews of the Estuary Management Plan should include community information/reporting about the assessed progress and opportunities for the local community to comment on new actions or priorities. The SRNRFMC would play a key role in this process.

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Internet sites for the following organisations:

- NSW Department of Natural Resources;
- NSW Department of Environment and Conservation;
- NSW Maritime Authority;
- NSW Department of Primary Industries;
- NSW Department of Lands;

- Southern Rivers Catchment Management Authority;
- Shoalhaven City Council;
- Australian Department of Agriculture, Fisheries and Forests;
- Australian Department of Transport and Regional Services; and
- Australian Department of Environment and Heritage.

Department of Environment and Conservation	National Parks and Wildlife Act. Threatened Species Conservation Act. Protection of the Environment Operations (POEO) Act. Plans of Management for Nature Reserves (Coomonderry Swamp, Brundee Swamp and Saltwater Swamp).	Responsible for research and protection of both natural ecological values (water quality, threatened species and endangered ecological communities) and Indigenous cultural heritage values, both within National Park estate and on other land. DEC also regulates major industry. The POEO Act and related policy documents set discharge standards to protect the values of receiving waters (e.g. for protection of aquatic ecosystems, or for primary or secondary contact recreation).
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