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Wollongong City Council

# **Estuary Management Plan for Several Wollongong Creeks and Lagoons**

## Estuary Management Study and Plan

December 2007





## Executive Summary

GHD was commissioned by Wollongong City Council to complete an Estuary Management Study and Plan (EMSP) for ten creeks and lagoons in the Wollongong local government area (LGA). The study area comprised the tidal waterways, foreshores, surrounding open space and adjacent lands of the following estuaries:

- » Tom Thumb Lagoon (including Springhill and J.J. Kelly catchments);
- » Bellambi Lagoon;
- » Bellambi Gully (including Farrahars Creek catchment);
- » Collins Creek;
- » Whartons Creek;
- » Slacky Creek;
- » Flanagans Creek (including Thomas Gibson Creek);
- » Stoney Creek;
- » Stanwell Creek; and
- » Hargraves Creek.

The EMSP was developed to take into consideration the findings and outcomes of the earlier Estuary Processes Study (EPS) completed by GHD in 2007. The EPS concluded that the key issues associated with many of the estuaries included:

- » Poor water quality, with elevated faecal coliforms making the estuaries unsuitable for primary, and sometimes secondary, contact recreational activities, plus elevated nutrients and heavy metals, and low dissolved oxygen concentrations;
- » The conservation, and where possible, the enhancement, of ecological values, including the appropriate management of Endangered Ecological Communities, aquatic vegetation (seagrasses, saltmarsh, mangroves), and riparian habitat of potential value to threatened species;
- » The management of threats to the ecological values of the estuaries including the decline and/or weed invasion of riparian vegetation and EECs; loss of fauna and riparian habitat through urban development; inappropriate levels of, or impacts from, recreational use (particularly at Bellambi Lagoon); introduced fauna preying on native fauna; urban runoff containing high levels of nutrients, with possible impacts on algal blooms; industrial and/or contaminated runoff entering Tom Thumb Lagoon; and impacts on water quality from sewage, industrial and residential sources;
- » The maintenance and improvement of water quality and fishery habitat in the estuaries, and in particular the conservation of seagrasses and mangroves;
- » The management of areas of potential and actual bank erosion; and
- » The conservation of cultural heritage values, and in particular the Aboriginal middens and associated sites at Bellambi Lagoon.

These issues have been addressed in this EMSP through the development of management objectives designed to achieve the maintenance of existing estuarine conditions, together with measures to provide



future improvements in estuary functions. Management strategies and actions have been developed to achieve the outcomes associated with the management objectives, and these have been subject to a cost benefit analysis to determine the most cost-effective actions. The actions form the basis for the Estuary Management Plan, the implementation of which will be managed by Wollongong City Council and the Estuary Management Committee.

A monitoring plan has been developed to ensure that the success of the implementation of the management actions is assessed and periodically reviewed.

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# 1. Introduction

## 1.1 Estuary Management Process

Wollongong City Council (WCC) engaged GHD to prepare an Estuary Processes Study (EPS) and Estuary Management Study and Plan (EMSP) for ten creeks and lagoons in the Wollongong local government area (LGA). The EPS has been reported in a separate document (GHD, 2007).

This EMSP was prepared under the NSW Government's Estuary Management Program and developed in accordance with the requirements of the NSW Estuary Management Policy (1992) and NSW Coastal Policy (1997). This EMSP builds on the findings of the EPS.

Figure 1.1 summarises the NSW Government's estuary management process. The estuary management program is administered by the Department of Environment and Climate Change (DECC; formerly the Department of Natural Resources), which provides a subsidy to local councils of up to 50% of the cost of completing each stage of the process.

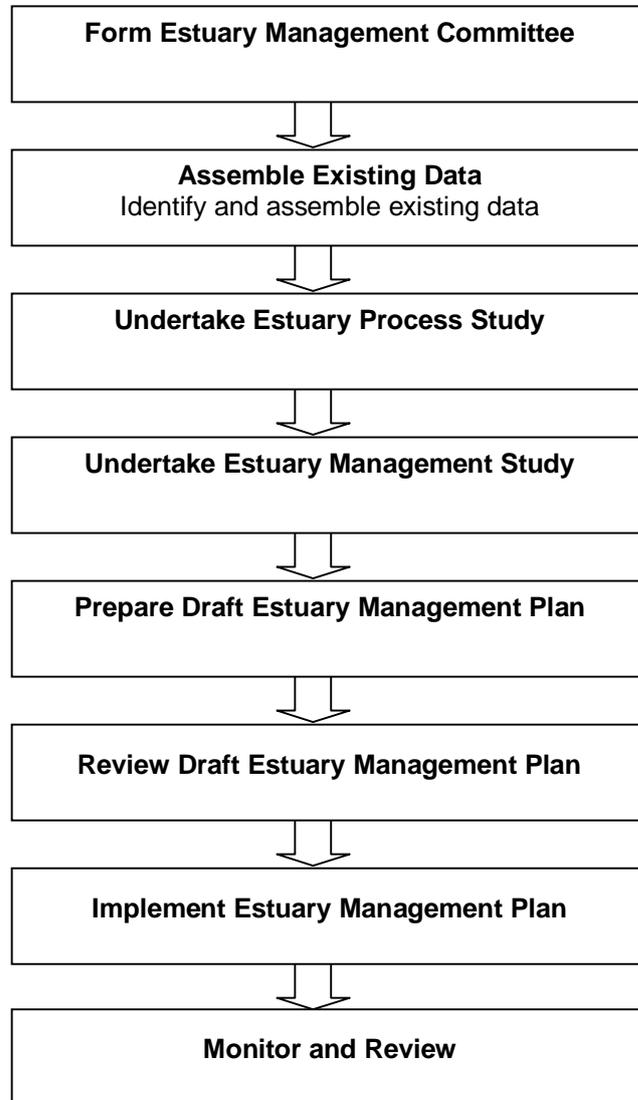
WCC has formed an Estuary Management Committee (EMC) to oversee the process. The committee membership includes Councillors, Council staff, representatives of relevant authorities and agencies, local community groups and users of the estuary.

Steps two and three in the estuary management process are the identification of existing available information and data for the subject estuaries, and undertaking the EPS. The data compilation study undertaken for this project was prepared by WBM Oceanics (2006). The EPS study undertaken by GHD (2007) defined the existing condition of the various estuarine processes and their interactions. The EPS also documented the physical processes, water quality, ecological and biological parameters and the extent to which human activities have impacted upon estuarine processes.

The information and data obtained during the EPS has subsequently been used to develop this EMSP, which identifies the essential features and current uses of the estuaries and develops overall management objectives for them. This EMSP also identifies the management strategies and actions necessary to achieve the management objectives.



**Figure 1.1 NSW Government Estuary Management Process**



## **1.2 Scope of Estuary Management Study and Plan**

This EMSP addresses the tidal waterways, foreshores, surrounding open space and adjacent lands of:

- » Tom Thumb Lagoon (including Springhill and J.J. Kelly catchments);
- » Bellambi Lagoon;
- » Bellambi Gully (including Farrahars Creek catchment);
- » Collins Creek;
- » Whartons Creek;
- » Slacky Creek;
- » Flanagans Creek (including Thomas Gibson Creek);

- » Stoney Creek;
- » Stanwell Creek; and
- » Hargraves Creek.

The ten estuary, coastal creek and lagoon systems are described in detail in the Estuary Processes Study.

This EMSP has been developed to:

- » Document specific legislation related to the estuary and future estuary management objectives, with some assessment of local planning controls;
- » Summarise the outcomes of the community consultation undertaken as part of the process;
- » Identify the essential features of each estuary, including their physical, chemical, ecological, economic, social and aesthetic values;
- » Outline the estuary management issues, detailing human interaction and usage, and issues of concern;
- » Identify and assess appropriate management objectives that will result in the ongoing protection and enhancement of the estuary values; and
- » Outline an estuary management plan that details the management strategies and actions necessary to achieve the management objectives.

### **1.3 Study and plan objectives**

The development of the EMSP objectives is fundamental to the Estuary Management Process defined by the NSW Government. The EMSP objectives are outlined below:

- » Overview and prioritise the conclusions developed and drawn from the process study;
- » Protect and improve estuary habitats including a focus on Endangered Ecological Communities, the rehabilitation of degraded areas and the regeneration of aquatic and terrestrial flora communities, including foreshore and riparian areas;
- » Maintain and improve existing water quality, encouraging healthy aquatic ecosystems and appropriate recreational uses;
- » Identify stakeholder and community desires and valued objectives for each site;
- » Minimise estuary sedimentation and erosion caused by human activities, and flooding impacts resulting in bank erosion;
- » Protect and retain areas of Aboriginal and European cultural heritage surrounding and directly including the estuaries;
- » Encourage ecologically sustainable development through the denoting of estuarine ecosystem limits and the identification of inappropriate development;
- » Minimise impacts from flooding on existing and future development in accordance with existing council Floodplain Risk Management Plans;
- » Maintain or improve the intrinsic value and natural integrity of the local landscape of the estuaries;



- » Achieve an appropriate opening regime for each estuary specifically, balancing the problems of water quality, ecology and flooding;
- » Facilitate community education, involving the public regularly in planning and development activities; and
- » Develop a plan that is conceptually simple though scientifically accurate, the definition of performance targets and introduction of audited monitoring programs.

#### **1.4 Study background and processes overview**

This report documents the EMSP and has been developed to identify and expand on the conclusions and themes documented in the EPS report.

As part of the EPS report, a literature review was completed to identify issues and themes that are considered to be integral components affected by, or affecting, the successful management of the Wollongong estuary systems. The EPS report also documented the current physical condition and overall health of the estuaries through an assessment of their aquatic and riparian ecology, basic hydrology and geomorphology, together with a review of existing water quality information. Consultation with key stakeholders was also undertaken to identify community values and concerns relating to the estuary-specific functioning and management of the estuaries, and is documented in this EMSP. The community consultation was an important component in the subsequent development of appropriate management objectives, strategies and actions for each catchment.

Each estuary system is highly influenced by their location and catchment characteristics. The health of the estuary systems can also be significantly impacted by both physical constraints placed upon it and pollution from a range of sources. Many of the estuaries exhibited signs of poor overall ecological aquatic health by way of high nutrient levels, low dissolved oxygen concentrations, and high levels of faecal coliforms.

The estuarine reach of most of the estuaries is confined to a narrow corridor extending inland for less than 500 m and many were constrained on either bank by foreshore recreational areas (cycleways, footpaths, parkland) or residential development. However, the upper and middle catchment areas of most estuaries were associated with extensive urban development with approximately 60-90 % of the catchment being developed land. Only the northernmost creeks (Hargraves, Stanwell and Stoney Creeks) had little urban or suburban development in the catchments.

The aquatic and riparian flora and fauna surveys completed as part of the EPS identified some of the significant ecological values and issues associated with each catchment. The key issues included the presence and impact of weed invasion of riparian vegetation and areas of Endangered Ecological Communities, habitat fragmentation as a result of urban development in the catchment, a paucity of suitable habitat for significant native fauna species, and the presence of introduced, non-native fauna species, including foxes and the Eastern Mosquitofish or *Gambusia*.

The diffuse and untreated nature of urban stormwater pollution was identified as contributing high levels of nutrients to the estuaries, contributing to the likely development of blooms of macroalgae (which smother other aquatic habitats such as seagrasses, particularly in Bellambi Lagoon) and also phytoplankton. Stormwater runoff from industrial areas and contaminated land, plus licensed discharges from industrial sites in the catchments, are also likely to be contributing to poor estuary water quality, with consequent impacts on the development and maintenance of healthy ecological systems and processes.

Many of the estuaries are used for primary (swimming) and secondary (paddling, fishing, etc) recreational contact, particularly by young children for whom bathing in the surf zone at the beach is considered to be unsafe. However, faecal coliform levels in the estuaries may exceed guideline levels for primary recreational contact, and may also exceed the guideline levels for secondary recreational contact at times, raising concerns over the use of the estuaries for recreational contact activities that might result in water being ingested.

The geomorphology assessment of the estuaries identified a number of areas that require management to prevent or minimise erosion, and included a brief assessment of the accessible upstream freshwater reaches. Areas of the Stanwell Creek estuary require future management of ongoing erosion that currently threatens road and car park assets, while Whartons Creek has active bed erosion that is forecast to extend should action not be taken to rectify it. Bellambi Lagoon and Bellambi Gully are also considered to require priority investigation of erosion areas in both the estuarine and freshwater reaches.



## 2. Policy and Legislative Framework

### 2.1 Overview

The objective of this chapter is to establish the context for the EMSP in terms of the legislative framework and policy directions of Council and Government.

The chapter is divided into four areas:

- » Integrated coastal zone management;
- » Wetlands, riparian lands and habitat management;
- » Planning documents;
- » Natural resource management legislation; and
- » Cultural heritage legislation.

### 2.2 Integrated coastal zone management

Coastal zones are typically sensitive areas where a number of ecosystems exist in a state of balance. The management of such an area is multidisciplinary effort involving a range of ecological, social, cultural, governance and economic considerations. Some key management policies and legislation include the following.

#### 2.2.1 NSW Coastal Policy 1997 and Coastal Protection Act 1979

The NSW Coastal Policy seeks to balance population growth and economic development in a sustainable way. The Policy aims to reduce the level of impact or risk placed on the natural, cultural, spiritual and heritage values of the coastal environment by incorporating ecologically sustainable development. One of the Policy's key themes is coastal water quality and especially estuaries. The Coastal Protection Act recognises the social and economic benefits to the State resulting from sustainable use of the coastal environment and aims to provide for the sustainable use of the NSW coast.

#### 2.2.2 State Environmental Planning Policy (SEPP) 71: Coastal Protection

SEPP 71 aims to ensure that development in the NSW coastal zone is appropriate and suitably located. The Policy provides a consistent and strategic approach to coastal planning to ensure a clear development assessment framework for the coastal zone and protects the coastal area of the estuaries studied in this plan.

#### 2.2.3 Comprehensive Coastal Assessment

In applying the legislative framework above, the NSW Government uses a Comprehensive Coastal Assessment system to protecting coastal areas. The Government has produced a "Comprehensive Coastal Assessment Toolkit" to assist councils, government agencies and other stakeholders to undertake strategic land use planning. The Toolkit provide for a three stage process where base line information (stage 1) is used in developing indicators (stage 2) that are then used to measure the performance of different planning options (stage 3).



## **2.3 Wetlands, riparian lands and habitat management**

Within the coastal zone there are many individual vegetation communities and ecosystems, including those associated with watercourses, that need protection. Specific policies are applied to these areas to cater for their protection.

### **2.3.1 Wetlands Management Policy 1996**

The NSW Government promotes the conservation, sustainable management and use of wetlands and developed the Wetlands Management Policy to reflect this aim. The Policy gives consideration to the biophysical requirements of wetlands within all NSW Government decision-making and assists in protecting wetlands in good condition and rehabilitating degraded wetlands where feasible.

### **2.3.2 Policy and Guidelines – Aquatic Habitat Management and Fish Conservation**

The Policy and Guidelines for Aquatic Habitat Management and Fish Conservation is designed to achieve consistent management of aquatic resources in NSW waters. The Policies and Guidelines apply to all planning and development proposals in NSW that affect freshwater, estuarine and marine ecosystems. They seek to assist developers, consultants, planners, local councils and other government agencies in assessing proposals.

### **2.3.3 Rivers and Foreshores Improvement Act 1948**

The Rivers and Foreshores Improvement Act protects riparian vegetation and rivers, lagoons, foreshores and lakes by specifying that a person must not excavate within, in or under land that is the bank, shore or bed of any river, lagoon or lake, or within 40 m of these areas without a permit. The Act protects the estuarine and riparian areas of the estuaries assessed in this Plan.

### **2.3.4 Fisheries Management Act 1994**

The Fisheries Management Act and Regulations ensure that biological diversity is maintained and fishing activities remain sustainable throughout NSW. The State Government views the State's fisheries as a community-owned resource with the onus on users to protect and safeguard this resource. The FM Act requires that a permit is obtained prior to the undertaking of certain estuary works, including any works that will affect mangroves or seagrasses, or obstruct fish passage.

### **2.3.5 State Environmental Planning Policy (SEPP) 14: Coastal Wetlands**

SEPP 14 seeks to preserve and protect coastal wetlands for their environmental and economic values. The Policy applies to the Wollongong local government area and identifies over 1300 wetlands of high natural value along the NSW coastline. The policy restricts land clearing, levee construction, drainage work or filling in any nominated wetland unless Council and the Department of Planning have granted approval.

There are 17 wetlands in the surrounds of Lake Illawarra that are protected under this Policy (WCC 2002). However none are within the estuaries under the scope of this study.

### **2.3.6 State Environmental Planning Policy (SEPP) 26: Littoral Rainforests**

SEPP 26 provides a similar function to SEPP 14 for the preservation and protection of littoral rainforests. Littoral rainforests are a unique habitat that is well suited to harsh salt-laden and drying coastal winds. The Policy requires an environmental impact assessment to be prepared outlining any effects on protected littoral rainforest areas. The policy applies to 'core' areas of littoral rainforest as well as a 100 metre wide 'buffer' area surrounding these core areas with the exception of where residential land exists or where SEPP 14 applies. Wollongong local government area does not contain any littoral rainforests covered by SEPP 26, however there are many significant stands of this rainforest type in the Wollongong LGA, especially on the foreshores and islands of Lake Illawarra (WCC 2002).

### **2.3.7 State Environmental Planning Policy (SEPP) 44: Koala Habitat Protection**

This Policy aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for koalas, thus reversing the current trend of koala population decline. The Policy encourages the identification and protection of core koala habitat and requires the preparation of plans of management before development consent can be granted in such areas

The Policy applies to the Wollongong local government area and a survey of listed koala feed tree species was undertaken at each of the estuaries during the EPS.

## **2.4 Planning documents**

Planning policies and legislation provide for the orderly development of land. They ensure that development proposals are consistent with relevant legislation and ensure the ongoing sustainable development of an area into the future.

### **2.4.1 Environmental Planning and Assessment (EP&A) Act 1979**

The EP&A Act governs the assessment of development and land use proposals as well as the preparation of Environmental Planning instruments such as Local, Regional and State Environmental Plans. The Act ensures that the consent authority (usually Council or State Government) consider the environmental impacts of new development.

### **2.4.2 Illawarra Regional Strategy**

The Illawarra Regional Strategy was prepared by the Department of Planning in consultation with local councils and is a 25-year plan for the strategic development of Wollongong, Shellharbour and Kiama local government areas. The plan provides a strong focus on jobs growth and the sustainable settlement of a fast growing population. The plan envisages an addition 47,600 people living in the area by 2031, requiring 38,000 new dwellings – population growth that will continue to place pressure on sustainable development within the City's estuaries.

### **2.4.3 City of Wollongong Local Environmental Plan 1990**

Wollongong's local environmental plan (LEP) is the primary local planning document that guides development in the local government area. The LEP zones land for particular types of use, including residential, commercial or industrial areas, open spaces and other protected areas. The LEP identifies what types of development are allowed to occur in different zones.



The LEP also identifies standards for subdivision, maximum floor space on blocks of land, and lists heritage items in the City. The LEP has been amended numerous times and is currently subject to a major review in line with State Government requirements.

Development Control Plan 54 – Managing our Flooding Risks, and the Riparian DCP currently in preparation provide for specific measures to address the potential impacts of development on flooding risks and the riparian zone.

## **2.5 Natural resource management legislation**

Natural resource management provides for the sustainable use of natural areas to ensure that future generations have equitable access to adequate natural resources. Natural resource legislation is applied at the Federal, State and local level.

### **2.5.1 Environment Protection and Biodiversity Conservation (EPBC) Act 1999**

The EPBC Act is a Commonwealth Act that requires the Federal Environment Minister's approval for an action that will, or is likely to, have a detrimental or adverse impact on a matter of National Environmental Significance (NES) or on Commonwealth Land unless the action is exempt.

Matters of NES currently include World Heritage properties, Ramsar Wetlands, Nationally Threatened Species and Ecological Communities, Migratory Species, Commonwealth Marine Areas, Nuclear Actions and Natural Heritage Places.

### **2.5.2 Threatened Species Conservation Act 1995**

The Threatened Species Conservation Act provides for the protection and conservation of threatened ecological communities, populations and individual species of plants and animals in NSW. The Act identifies 'threatened' species and refers to the test in Section 5A of the Environmental Planning and Assessment Act to assess likely impacts of development on any threatened species, populations or communities.

### **2.5.3 Protection of the Environment Operations (POEO) Act 1997**

Pollution control and waste disposal is governed in NSW by the POEO Act. This legislation requires the assessment of certain activities that are likely to have an adverse environmental impact and for an application to be made for an Environment Protection Licence.

### **2.5.4 Noxious Weeds Act 1993 (NW Act)**

The Noxious Weeds Act outlines the definition, declaration, and control of noxious weeds throughout NSW. Local government are responsible for ensuring that the Act is complied with within their boundaries.

For a plant to be declared a Noxious Weed it must be considered to pose a serious threat to humans, agriculture and/or the environment. There must also be consideration given to the feasibility of control and enforcement of those methods. Plants are declared noxious by order of the Minister for Agriculture.

Land owners or occupiers have obligations under the Act to control any declared weed on their property. Council is required to conduct inspections of private properties to check compliance with the Act and Noxious Weed Officers have the authority to issue control notices for any breach.

### **2.5.5 Native Vegetation Act 2003 (NV Act)**

The Native Vegetation Act provides for the management of native vegetation on a regional basis in the social, economic and environmental interests of the State. The Act prevents broadscale clearing unless under strict circumstances and protects native vegetation of high conservation value.

The act also seeks to improve the condition of existing native vegetation, particularly where it has high conservation value and to encourage the revegetation or rehabilitation of land with appropriate native vegetation.

The Act applies to Wollongong LGA and protects native vegetation in the estuaries in areas zoned as public open space, conservation and environmental.

## **2.6 Cultural heritage legislation**

The management of cultural heritage items, relics and places ensures that the heritage values are conserved for the benefit of the community. Cultural heritage legislation is applied at the Federal, State and local level as described in the following sections.

### **2.6.1 The National Parks and Wildlife Act 1974**

The National Parks and Wildlife Act 1974 (NP&W Act, 1974) provides the primary basis for the legal protection and management of Aboriginal sites within NSW. The implementation of the Aboriginal heritage provisions of the Act is the responsibility of the Department of Environment and Climate Change (DECC). The Act aims to prevent the unnecessary or unwarranted destruction of relics, and the active protection and conservation of relics that are of high cultural significance.

Under Section 87 of the Act, it is an offence to disturb or excavate any land for the purpose of discovering an Aboriginal object, disturb or move an Aboriginal object, or to take possession of or remove an Aboriginal object from certain lands, without a permit from the Director-General of DECC.

### **2.6.2 The National Parks and Wildlife Amendment Bill 2001**

Although this Act was passed by both houses of the NSW parliament in 2001, a number of its provisions with regard to Aboriginal cultural heritage have yet to be gazetted and are not yet law. These include the offence under section 90 of the NP&W Act, 1974 of 'knowingly' destroying, defacing or damaging Aboriginal objects and Aboriginal Places without consent will be changed so that the element of knowledge will be removed. The amended section 90, subsection 1 will read 'A person must not destroy, deface, damage or desecrate, or cause or permit the destruction, defacement, damage or desecration of, an Aboriginal object or Aboriginal place.'

### **2.6.3 The NSW Heritage Act (1977)**

The purpose of the NSW Heritage Act 1977 is to ensure that the heritage of New South Wales is adequately identified and conserved. In practice the NSW Heritage Act has focused on items and places of non-indigenous heritage to avoid overlap with the NP&W Act, 1974 which has primary responsibilities for nature conservation and the protection of Aboriginal relics and places in NSW.

The Heritage Act is concerned with all aspects of heritage conservation and recognises two levels of heritage significance, State significance and Local significance. The Act provides protection to items that



have been identified, assessed and listed on various registers including State government section 170 registers, local government LEPs and the State Heritage Register.

#### **2.6.4 The National Trust (NSW)**

Whilst the National Trust Register does not provide any statutory obligations for protection of a site, the acknowledgment of a place being listed on the Register as a significant site lends weight to its heritage value.

#### **2.6.5 Environmental Planning & Assessment Act (1979)**

The Environmental Planning & Assessment Act 1979 (EP&A Act) and its regulations, schedules and associated guidelines require that environmental impacts, including those to cultural heritage, are considered in land use planning and decision making.

#### **2.6.6 Commonwealth Cultural Heritage Legislation**

The Environment and Heritage Legislation Amendment Act (No 1) 2003, Australian Heritage Council Act 2003, and the Australian Heritage Council (Consequential and Transitional Provisions) Act 2003 replace the previous Commonwealth heritage regime instigated by the Australian Heritage Commission Act 1975.

The Acts establish the National Heritage List, which is a schedule of places which the Minister for the Environment and Water Resources considers to have 'National Heritage Value' based on prescribed 'National Heritage Criteria'. The listing of a place is defined as a 'matter of national environmental significance' under the Environment Protection & Biodiversity Conservation Act 1999. As a consequence, the Minister must grant approval prior to the conduct of any proposed actions which will, or are likely to have, a significant impact on the National Heritage values of a listed place.

## 3. Community and Stakeholder Consultation

Consultation with state government agencies, local government, industry and local communities was undertaken to provide an opportunity for stakeholder participation in the estuary management plan process. Key stakeholders with an interest in the development of the plan were invited to raise issues and participate in the consultation phase.

The identification of stakeholders was an ongoing process, with consultees being added to the mailing lists when they attended site visits or made contact with GHD or WCC in relation to the study.

### 3.1 Objectives

The objectives of the consultation program included:

- » Communicating with the community about the estuary management plan process;
- » Providing stakeholders with an opportunity to contribute information and local knowledge;
- » Providing stakeholders with an opportunity to identify issues of concern, and potential management objectives and strategies that might address their concerns;
- » Building trust and relationships between Council and the community; and
- » Establishing a mechanism for stakeholders to review, and provide comments on, the draft estuary management plan reports.

### 3.2 Key Stakeholders

Key stakeholders were identified from relevant state government agencies, Council departments, local industry, Aboriginal groups, environmental and community groups, and representatives from Council's Estuary Management Committee (EMC), as detailed below:

#### *State Government Departments/Corporations*

- » Department of Primary Industries - Fisheries (DPI);
- » Department of Environment and Climate Change (DECC - formerly the Department of Environment and Conservation)
- » Department of Natural Resources (now part of the DECC);
- » Department of Planning (DoP);
- » Department of Lands (DoL);
- » Southern Rivers Catchment Management Authority (SRCMA); and
- » Sydney Water.

#### *Wollongong City Council*

- » Estuary Management Committee;
- » Works and Services Division;
- » Recreation & Natural Resources Division (now Environment and Recreation Division);



- » Environment & Health Division;
- » City Strategy Division; and
- » Floodplain Management Section.

*Community and Environment Groups*

- » Conservation Volunteers Australia (CVA);
- » Wollongong University (School of Biological Sciences);
- » Bellambi Lagoon Protection Society;
- » Friends of Towradgi Park;
- » Friends of Tom Thumb Lagoon; and
- » Northern Illawarra Residents Action Group.

*Aboriginal Organisations*

- » Illawarra Local Aboriginal Land Council; and
- » Northern Illawarra Aboriginal Collective.

*Industry*

- » BlueScope Steel; and
- » Illawarra Coke Company Pty Ltd.

### 3.3 Consultation Activities

A range of consultation activities were undertaken during the preparation of the estuary management plan in order to facilitate the participation of as many interested parties as possible. A summary of the consultation activities is provided in Table 3.1.

**Table 3.1 Key modes of communication and consultation**

Communication	Purpose	Outcome
Media Notices	A notice was published in the Northern Leader Newspaper to raise community knowledge about the estuary management planning process, and to invite participation from interested parties.	A total of two people responded to the advertisement, and raised comments relating to Stanwell and Hargraves Creeks.
Consultation Letters	Consultation letters outlining the estuary management process were sent to all key stakeholders. The letter invited community participation, and provided a range of mechanisms (phone, fax, email or letter) through which comments could be raised.	A total of 39 representatives were consulted by letter, and 11 people/groups responded (28%).
Estuary	EMC meetings were held on 21 March and 28	A total of 22 people

Communication	Purpose	Outcome
Management Committee (EMC) Meetings	<p>June to provide an opportunity for key stakeholders to learn more about the estuary management process and contribute to the development of management objectives, strategies and actions.</p> <p>GHD provided a short presentation on 21 March, outlining the estuary management planning process and preliminary findings from the Estuary Processes Study.</p> <p>GHD presented the draft EPS and EMSP to the EMC on 28 June.</p> <p>The meetings provided an opportunity for representatives to discuss the project directly with WCC staff and GHD.</p>	<p>attended the EMC meeting on 21 March.</p> <p>A total of 18 people attended the EMC meeting on 28 June.</p>
Councillor Presentation	<p>GHD presented the draft EPS and EMSP to Wollongong City Councillors at a briefing on 25 June.</p>	<p>Councillors provided input to the draft documents for incorporation during finalisation of the reports.</p>
Site Visit	<p>WCC and GHD hosted a half-day tour of all the estuaries on 1 May 2007, providing stakeholders the opportunity to view each estuary, identify their estuary-specific issues, and gain an appreciation of the issues common to all estuaries. The tour provided stakeholders with the opportunity to discuss the proposal directly with the WCC and GHD project managers, and provided a useful forum for stakeholder feedback.</p>	<p>A total of 12 stakeholders attended the site visits, including DPI (Fisheries), DECC, SRCMA, DoP, CVA, EMC representatives and Councillors.</p>
Telephone	<p>GHD's project manager was available by direct telephone contact for key stakeholders to raise any issues. GHD followed up letters sent to Aboriginal representatives by telephone on several occasions but was unsuccessful in eliciting further comments.</p>	<p>A total of four people contacted GHD by telephone to raise issues to be addressed in the EMP.</p>
Email	<p>GHD's project manager was available by direct email contact to handle ongoing queries from key stakeholders and to provide a forum for information exchange and registration of comment about the EMP.</p>	<p>A total of four people contacted GHD by email to raise issues to be addressed in the EMP.</p>

### 3.4 Consultation Issues/Comments

A summary of comments received during the various consultation activities is provided in Table 3.2. The majority of issues and comments raised are applicable to most or all catchments. Where estuary-specific comments or issues were raised, these have been noted.



**Table 3.2 Summary of consultation responses**

Issue	Issues and Comments to be Addressed
Water Quality	Siltation and sedimentation resulting in turbidity, suspended solids and organic loading.
	Water flow, erosion, sedimentation and stormwater and the actions to mitigate these impacts.
	Urban developments and their effect on water quality.
	CVA noted that the Plan of Management for Tom Thumb Lagoon recommends source control of pollution within the catchment of Tom Thumb Lagoon.
	Granular material used to repair Lower Beach Road is washed during rains into the adjacent Stanwell Creek, resulting in siltation that has significantly reduced the depth of the creek.
	The closure of BlueScope Steel's Tin Mill has reduced the discharge of process effluent to Port Kembla and Tom Thumb Lagoon, and might contribute to an improvement in localised water quality.
	Approximately 25% of residential properties are still not connected to the Priority Sewerage Program for Coalcliff, Stanwell Park, Otford and Stanwell Tops, resulting in a continued risk of sewerage overflows into Hargraves, Stanwell and Stoney Creeks.
	Flushing issues related to an unusual rainfall/runoff relationship as a result of small/short catchments linked to the very steep escarpments.
	An ephemeral tributary of Hargraves Creek was reported to consistently have a large amount of bubbles and a grey colouration following rainfall events. This has been apparent for the last 10 years.
	Operational discharges from industry into creeks.
	Contaminated sites in some catchments, resulting in impacts due to waste emplacements.
	Nutrient cycling and the impact of sewage overflows
	Flora
DECC recommended that the plan address surrounding landuses, and identify all places where water can enter the creek, including runoff, stormwater outlets and licensed discharge points. The EMP should include actions to minimise any impacts from surrounding landuses.	
	Disturbance of vegetation, particularly Coastal Saltmarsh (EEC).
	Limited knowledge of seagrass and aquatic weed interactions.

Issue	Issues and Comments to be Addressed
	<p>Mangrove incursion on saltmarsh areas in Tom Thumb Lagoon.</p> <p>Loss of seagrasses.</p> <p>Disturbance of Endangered Ecological Communities (EECs).</p> <p>DPI recommended that the plan identify proposed management/strategies/actions to address current impacts on aquatic habitats, such as rehabilitation of aquatic habitats and the riparian zone through creation of riparian buffer zones, replanting with native vegetation and weed removal, controls and restrictions on foreshore development and unauthorised structures and access points, and measures to monitor and improve water quality (including monitoring programs, installation of stormwater controls, gross pollutant traps, and sediment basins).</p> <p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends weed control and ongoing bush regeneration.</p> <p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends the diversification of terrestrial plant species along wetland margins.</p> <p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends the removal of mangroves from outside the mangrove zone.</p> <p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends minor earthworks improvements, including the creation of seagrass beds.</p> <p>DPI requested that the plan provide a description and the current status of aquatic habitats (mangroves, seagrass, saltmarsh, wetlands, riparian vegetation) and key aquatic species (including any threatened species listed under the FM Act) located in each creek or lagoon and their regional significance.</p>
Fauna	<p>Loss of nursery habitat for fish stocks.</p> <p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends the creation of Green and Golden Bell Frog ponds.</p> <p>Analysis of current adverse impacts upon all aquatic habitats (both direct and indirect) from human use and activities and developments in the catchment.</p> <p>Protection of dune corridors behind Bellambi Lagoon beach, which provide important habitat connectivity.</p> <p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends the control of feral animals, where possible.</p>
Threatened Species Habitat	<p>Protection of habitat for the Green and Golden Bell Frog at Bellambi Lagoon and Tom Thumb Lagoon.</p> <p>Ensure Bellambi Lagoon islands are maintained to provide protected nesting habitat for threatened bird species.</p> <p>DECC recommends that the plan include an assessment of threatened species, EECs, endangered populations and key threatening processes, as well as any recovery plans.</p>



Issue	Issues and Comments to be Addressed
Aboriginal Heritage	DECC recommended that consultation with Aboriginal communities be undertaken, and that the plan identify the nature and extent of Aboriginal cultural heritage values across the study area, and ensure no works impact on these sites.
	Protection of the Aboriginal birthing site on the eastern side of Bellambi Lagoon, including skeletons of children, plus middens and other sites along the beach and dune area.
Artificial Entrance Openings	Concern with artificial entrance opening regimes and it's impacts on lagoon ecology, particularly at Bellambi Lagoon.
	DECC recommends that the plan include a description of the current situation and history of entrance opening of each estuary, plus an assessment of potential impacts, including but not limited to, bank erosion, longevity of artificial opening, alteration of the natural tidal flow and potential odour impacts.
	Residents would like to see a return to a natural regime of entrance openings, stating that artificial openings do not improve water quality or odour, and disturb soils, flora and fauna.
	Opening lagoons by digging channels to improve surf conditions should be penalized by fines.  DPI recommended that the plan identify proposed measures for dealing with any artificial openings of estuary entrances (eg. development of entrance management policies).
Access	Sydney Water requires vehicle and foot access for maintenance and inspection of water and sewerage infrastructure.
	Vehicles should not be permitted on the beaches. Gates should be provided to limit access.
	Unauthorised beach access points should be controlled and restricted.
Development	Controls and restrictions should be developed for foreshore development and unauthorised structures.
	Dunes should be maintained to provide storm protection and natural function.
	Development close to the edge of creeks, without consideration of flood risks or impacts from natural estuary processes, should be minimised.
Coastal Geomorphology	Council should take into consideration soils when planning coastal developments.
	Acid Sulphate Soils are present in some catchments, their disturbance would have potential impacts.
	Dredging of lagoons might disturb Acid Sulphate Soils.
Hydrology	All three tributaries of Stoney Creek are dammed for the supply of water to the Illawarra Coke Company Pty Ltd, resulting in a non-natural hydrological response.

Issue	Issues and Comments to be Addressed
	<p>DPI recommended that the plan identify proposed strategies/actions for detailing the impacts of sea level rise.</p> <p>The relationship between entrance openings and flooding should be addressed.</p> <p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends the monitoring of tidal heights if the causeway across Gurungaty Waterway at Port Kembla is removed.</p>
Recreation / Human Health	<p>Water quality concerns relating to the use of the estuaries for primary and secondary recreational activities, particularly for small children.</p> <p>Estuaries in the past were safe for swimmers, fishers, canoeists and natural training facilities for lifesavers.</p> <p>The public is warned not to swim in the adjacent surf when the lagoon breaks out, but there are no notices warning the public of swimming in the lagoon areas.</p> <p>Estuaries are used to swim and wade, therefore there is a requirement to undertake more adequate water quality monitoring to determine faecal coliforms and heavy metal contamination.</p> <p>DPI recommended that the plan identify proposed strategies/actions for improving the quality of recreational fishing.</p> <p>Proposed future research studies of aquatic ecology in the estuaries.</p> <p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends the establishment and maintenance of public amenity features in Tom Thumb Lagoon once any safety risk has been addressed.</p>
Information Gaps	<p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends a geotechnical investigation of the old landfill (adjacent to Tom Thumb Lagoon), and its impacts on public health and ecosystems, specifically groundwater and surface water leaching into the saltmarsh of Tom Thumb Lagoon, plus implementation of any recommendations.</p> <p>Investigate options for the removal of a causeway located across Gurungaty Waterway at Port Kembla.</p> <p>Need more regular testing of water quality within the lagoons to see where changes are occurring.</p> <p>Details of when and how fish use lagoons as part of their breeding cycle, plus fish dietary requirements and their movement patterns.</p> <p>The altering state of sea grasses and other aquatic vegetation within the lagoons.</p> <p>The effect of blooms of green algae on other aquatic life within the lagoon.</p> <p>The importance of many invertebrates within the lagoon at the bottom of the food chain, and effect of increased lagoon flushing due to increase rain runoff due to urbanisation.</p>



Issue	Issues and Comments to be Addressed
	<p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends improved monitoring and reporting of estuary processes.</p> <p>DPI recommended that the plan identify proposed future research studies for aquatic ecology.</p>
Future Planning	<p>Implementation of EMP recommendations required.</p> <p>CVA noted that the Plan of Management for Tom Thumb Lagoon recommends the development of a strategic plan to develop partnerships between the community, business and government, to implement on-ground works and manage the ongoing rehabilitation of Tom Thumb Lagoon.</p> <p>Measures to monitor and improve water quality (such as monitoring programs, installation of stormwater controls, gross pollutant traps and sediment basins) are required.</p> <p>DPI noted that Fish Habitat Rehabilitation grants of up to \$30,000 are available to community groups and Councils to undertake works on a dollar-for-dollar basis (or in-kind contribution). Management Plan actions may be eligible for this funding.</p> <p>DPI noted that any future works might require approval from DPI, particularly those involving dredging, excavation, reclamation or filling works within a waterway, or for the removal or damage of any marine vegetation (including mangroves, seagrasses or macroalgae).</p>

### 3.5 Public Exhibition

The draft Estuary Management Study and Plan was placed on public exhibition from 17 September to 31 October 2007. The document was made publicly available on Wollongong City Council's website, at the front desk of Council's Environment and Health Division and at Helensburgh, Thirroul, Bulli, Corrimal, Central and Mobile libraries. The public exhibition was widely publicised in the local media.

Four community workshops were held during the public exhibition to provide the community with an opportunity to contribute to the development of the plan, and written submissions from the community were also encouraged.

Revisions to the draft Estuary Management Study and Plan were made, in consultation with the Estuary Management Committee, to address community comments received during the public exhibition period.

A detailed account of the public exhibition process, the various community consultation processes undertaken during it, community responses received, and actions taken to address the responses, is provided in the Submissions in Reply Report (GHD, 2007b).

## 4. Estuary Management Issues

This section identifies the estuary values, significance, essential features and uses, and document both general and estuary-specific issues of concern.

### 4.1 Estuary values, significance and essential features

Estuary values and essential features can be categorised into physical, ecological, economic and social categories, for which regional and national significance can be determined.

The Wollongong estuary systems are unique in their function and form, with all except for Tom Thumb Lagoon being intermittently closed and open lagoons (ICOLLs). The variable condition of their entrances makes them susceptible to human influences, with entrances occasionally being artificially opened to minimise the potential social and economic impacts associated with the flooding of surrounding properties.

This unique form and function of the estuary systems are in some cases important to populations of endangered species of flora and fauna, increasing the ecological values and regional significance of several of the estuaries. Of particular note are the endangered ecological communities at Hargraves Creek, Stanwell Creek, Collins Creek, Bellambi Gully, Bellambi Lagoon and Tom Thumb Lagoon.

Many of the lagoons are likely to contain places or items of Aboriginal heritage significance, and this is well documented for Bellambi Lagoon. Areas of non-indigenous heritage significance also exist within the catchments of Hargraves Creek, Flanagans Creek, and Bellambi Lagoon. The heritage value of these areas are locally significant and associated with either the landscape or with architectural designs and heritage buildings.

The economic significance of each estuary system can be attributed to expenditure associated with tourism, recreation, surrounding developable land, and sport. The estuaries provide valuable tourist and recreational areas and add to the regional and national appeal of the Wollongong area. There are numerous large recreation areas within many of the catchments, and particularly near the estuary entrances at the foreshore. These recreational areas provide significant economic benefit for local clubs, with numerous ovals and playing fields along the coastline, and provide an excellent recreation resource to the local community. These areas also provide additional flood storage in the event of major rainfall events.

The availability of developable land is an important issue within many high-density urban areas. The Wollongong area is further constrained by the presence of the high gradient slopes of the escarpment. Consequently, urban development in the catchments of the estuaries has often been maximised by constructing up to the banks of the creeks. This has resulted in many of the creeks (with the exception of Hargraves, Stanwell and Stoney Creeks) being extensively modified and straightened. The resulting steep banks often have little remnant native vegetation and are prone to erosion during high flow events. Many of the local soils are also susceptible to erosion, resulting in an elevated risk of severe bank erosion.

The geomorphology of the estuaries provides a significant flood storage volume that assists in minimising flood impacts to surrounding areas, and acts essentially as a detention basin. This function provides a valuable economic benefit to the local community.



Estuarine areas can provide very important fish breeding and nursery habitats that can contribute to the overall abundance and health of the local fish stocks, and could be expected to have an indirect economic influence on the value of the local commercial and recreational fisheries.

From a social perspective, the estuaries are highly valued for their recreational potential, which includes primary (swimming) and secondary (paddling, wading) recreational activities, together with other activities including fishing, kayaking, walking, picnicking and exercise.

## **4.2 Estuary uses**

The estuaries are utilised for many different purposes, and provide value to the wider community through the provision of a water resource to industry (Stoney Creek), recreational resource to the local population (most estuaries) and a range of other environmental, social and economic values.

The estuaries are used for primary recreational activities such as swimming, secondary recreational activities such as paddling and wading, and more passive recreation, such as picnicking and fishing. The majority of the primary and secondary contact recreational activities occur in the downstream lagoon and tidal areas, where the water quality often fails to meet the appropriate ANZECC guideline levels. Stanwell and Hargraves Creeks and their associated parks and foreshores also provide popular recreational areas. Vegetated areas surrounding many of the estuaries also provide recreational opportunities. In the case of Bellambi Lagoon, the impacts of inappropriate levels of recreational usage are particularly noticeable, and include a network of informal tracks created by trail bikers and walkers. The management of such activities, to prevent further degradation of the riparian vegetation and habitat fringing the estuaries, should be an important objective. Overall, the estuaries have a high recreational value, with Hargraves, Stanwell and Stoney Creeks, plus Bellambi Lagoon, providing the highest recreational value.

Development in the middle reaches of the catchments of many of the estuaries is predominantly residential but includes areas of commercial and light industrial development. The tributaries of Stoney Creek, which rise on the escarpment, are all impounded by the Illawarra Coke Company for the supply of water for use in the cokeworks. This is likely to have potential effects on the natural hydrological regime of the system that could, in turn, influence estuary conditions through reduced flushing. In contrast, the estuary of Tom Thumb Lagoon is almost entirely urbanised, and receives stormwater from the Wollongong CBD. The estuary is located within the heavy industrial area of Port Kembla and has been considerably modified over the last several decades from surrounding industrial development and reclamation. As a consequence the estuary has been substantially reduced in area, and receives storm water and other drainage from the surrounding industry, plus leachate from the old landfill to the north. Tom Thumb Lagoon also serves as a potentially important nursery area for fish and other aquatic/marine species, and is used by the local community as a foot and bicycle commuter corridor.

## **4.3 General issues of concern**

Issues of concern in relation to the maintenance and improvement of estuary processes and condition include water quality, the conservation of remnant vegetation and fauna species, improvements in the fish communities and stabilisation of bank erosion problems.

Water quality was identified as being of concern for most estuaries, with all being unsuitable for primary, and sometimes secondary, recreational contact. The majority also have low dissolved oxygen saturation values and high nutrient concentrations. These levels can be attributed to a number of

significant factors influencing the overall health of the estuaries, including the development of the catchment which contributes to urban stormwater, gross pollutants, sedimentation from poor construction management practices, plus sewage overflows during periods of high rainfall.

Some of the estuaries contain Endangered Ecological Communities (EECs), including Coastal Saltmarsh, Swamp Oak Floodplain and Bangalay Sand Forest. The EECs are subject to weed invasion, human disturbance and the encroachment of development. Areas of Coastal Saltmarsh were observed at six estuaries, Swamp Oak Floodplain at three estuaries and Bangalay Sand Forest at one estuary. State and Commonwealth legislation seeks to ensure the conservation and/or recovery of these communities through the development of appropriate management options.

Bellambi Lagoon contains a known area of Aboriginal heritage significance, and many of the other lagoons are also likely to contain such areas. The ongoing management and protection of areas of cultural heritage (including European heritage) is an issue of concern to the local community.

Untreated stormwater runoff can impact on a wide range of important estuary processes potentially influencing the overall health of any given system. Runoff can convey contaminants and pollutants into the estuary systems in concentrations and volumes that exceed the assimilation capacity of the system. Potential contaminants include gross pollutants, nutrients, heavy metals, pesticides, herbicides and petroleum hydrocarbons. Due to the large number of sources, the effective management of urban runoff is difficult to achieve, and it is usually very expensive to retrofit treatment systems into the existing urban landscape.

The majority of the estuaries were found to have little bank erosion, although isolated sections of moderate to highly active erosion were identified. Although the majority of the banks were stable, the channelisation and steep gradient of the banks, combined with the loss of native riparian vegetation, is likely to be associated with increased risk of bank erosion and slumping. The modification of channel geomorphology is also likely to have an impact on the hydraulic characteristics of the waterway compared to original conditions.

The management of estuary entrances is a complicated issue that may affect not only flooding impacts but also the ecological functioning of the system, particularly in relation to aquatic vegetation and fish communities. Although more than 50% of NSW ICOLLs are subject to artificial entrance breakout to prevent inundation of surrounding land, thereby minimising the economic impacts of flooding (Haines, 2006), local communities differ in their opinion of artificial openings. The artificial opening of estuary entrances can create an interruption of the natural hydraulic regime of ICOLLs, and can modify other physical, biological and chemical processes that can result in adverse impacts, including the terrestrialisation of estuarine wetlands and foreshores (Haines, 2006). In addition, the reduction of the artificial opening of coastal lagoons is identified by the Healthy Rivers Commission as an integral goal of their Coastal Lakes Strategy and hence critical to its inclusion to the management study and plan (HRC, 2002). The future management of openings is also important as predicted sea level rises will increase berm heights through normal coastal processes, which will in turn raise the maximum water level of ICOLLs, further threatening properties.

The provision of an adequate buffer zone between urban development and estuaries would be beneficial in attempts to maintain the natural functioning of ICOLLs, and represents a compromise between environmental and economic values.

Careful management of the estuaries will be required to ensure that potential conflicts between economic and environmental values are resolved effectively, particularly given the increasing pressures imposed



upon ICOLLS by continuing coastal development, population growth and climate change. The implementation of estuary-specific management objectives, strategies and actions will assist in ensuring the maintenance of the future functionality, viability and amenity of these important coastal features.

#### **4.4 Specific issues of concern**

Estuary-specific issues identified during the Estuary Processes Study are summarised below.

##### **4.4.1 Hargraves Creek**

The AWT (1999) survey data indicated that faecal contamination was particularly high at Hargraves Creek, particularly during wet weather periods, and was likely to be associated with sewage overflows. Prior to the commissioning of the new sewerage scheme the faecal coliform levels exceeded the secondary recreational contact guideline limit. Approximately 75% of residences have since been connected to the new sewerage scheme, but the remaining 25% of properties continue to pose a risk to water quality in the creek. Sydney Water implemented a water quality monitoring program in late 2006 to assess the effectiveness of the scheme in improving water quality. This estuary also has elevated nutrient levels. Consideration should be given to repeating the 1999 AWT macroinvertebrate monitoring study to assess current conditions and identify any improvements since construction of the sewerage scheme.

The presence of Coastal Saltmarsh EEC is of note, and management actions to monitor and manage potential weed invasion are required, together with the management of noxious weeds, and the conservation of potential habitats for several threatened amphibian and bird species.

The management of a significant area of ground disturbance upstream of Stanwell Tops, which is a potential sediment source, is also required.

##### **4.4.2 Stanwell Creek**

The AWT (1999) survey data indicated that faecal contamination was particularly high at Stanwell Creek, particularly during wet weather periods, and was likely to be associated with sewage overflows. Prior to the commissioning of the new sewerage scheme the faecal coliform levels exceeded the secondary recreational contact guideline limit. Approximately 75% of residences have since been connected to the new sewerage scheme, but the remaining 25% of properties continue to pose a risk to water quality in the creek. Sydney Water implemented a water quality monitoring program in late 2006 to assess the effectiveness of the scheme in improving water quality. Consideration should be given to repeating the 1999 AWT macroinvertebrate monitoring study to assess current conditions and identify any improvements since construction of the sewerage scheme.

The presence of Coastal Saltmarsh EEC Swamp Oak Floodplain EEC is of note, and management actions to monitor and manage potential weed invasion are required, together with the management of noxious weeds, and the conservation of potential habitats for several threatened amphibian and bird species.

##### **4.4.3 Stoney Creek**

The AWT (1999) survey data indicated that faecal contamination was particularly high at Stoney Creek, particularly during wet weather periods, and was likely to be associated with sewage overflows. Prior to

the commissioning of the new sewerage scheme the faecal coliform levels exceeded the secondary recreational contact guideline limit. Approximately 75% of residences have since been connected to the new sewerage scheme, but the remaining 25% of properties continue to pose a risk to water quality in the creek. Sydney Water implemented a water quality monitoring program in late 2006 to assess the effectiveness of the scheme in improving water quality. Consideration should be given to repeating the 1999 AWT macroinvertebrate monitoring study to assess current conditions and identify any improvements since construction of the sewerage scheme.

Water quality and the hydrological functioning of the creek are likely to have been affected by the impoundment of the headwater tributaries on the escarpment by the Illawarra Coke Company, together with any industrial discharges from the site.

#### **4.4.4 Flanagans Creek**

Flanagans Creek has generally elevated nutrient, total nitrogen, ammonia and nitrate levels, while faecal coliforms levels generally exceed the primary recreational contact guidelines. The poor water quality is confirmed by the low macroinvertebrate diversity, which is characteristic of urbanised catchments, water quality problems and/or loss of riparian habitat.

The catchment is affected by the loss of fauna and riparian habitat through clearing, weed invasion and urban development, and a short reach has been subject to recent riparian vegetation removal and minor bank erosion. The hydrological regime of the creek has been affected by the straightening of the creek near the entrance.

#### **4.4.5 Slacky Creek**

Slacky Creek has poor water quality characterised by low dissolved oxygen levels and elevated total nitrogen, ammonia and nitrate levels. The levels of manganese are also of concern for recreational purposes. The poor water quality is confirmed by the low macroinvertebrate diversity, which is characteristic of urbanised catchments, water quality problems and/or loss of riparian habitat.

The catchment is affected by the loss of fauna and riparian habitat through clearing, weed invasion and urban development.

The creek has approximately 100 m of minimally active, localized erosion of both banks, and some in-channel deposition of tailing-like sediments that may indicate erosion of upstream fill deposits.

#### **4.4.6 Whartons Creek**

The water quality at Whartons Creek is characterised by low dissolved oxygen levels, and elevated total nitrogen, nitrate, phosphorus, copper and zinc levels. Faecal coliform levels generally exceed the primary recreational contact guidelines. The poor water quality is confirmed by a low macroinvertebrate diversity.

The estuarine reach of the catchment has been extensively cleared of native riparian vegetation, and the banks have been extensively modified and are now vegetated by Kikuyu grass. The whole catchment is affected by the loss of fauna and riparian habitat through clearing, weed invasion and urban development.

Although the estuarine reach of the catchment is generally stable, with only a short section of minimally active erosion, there is a significant erosion head (with moderately active erosion downstream) located in



the freshwater reach, and a reported area of severe erosion on a tributary of Whartons Creek adjacent to Corrie Road. Both would benefit from attention in the short term.

#### **4.4.7 Collins Creek**

Collins Creek water quality is relatively poor and is reflected in the elevated levels of total nitrogen, nitrate, phosphorus, copper and zinc levels in some reaches. Faecal coliform levels generally exceed the primary recreational contact guidelines. The poor water quality is reflected by the low macroinvertebrate diversity.

The catchment is affected by the loss of fauna and riparian habitat through clearing, weed invasion and urban development, and of particular note is the potential effect on the Coastal Saltmarsh EEC. Although the catchment has been affected by the loss of fauna and riparian habitat, revegetation has been undertaken in places.

Areas of potential erosion, particularly on the outside of bends, are present throughout the reach downstream of the railway crossing, downstream of Thirroul Street, and downstream of a footbridge at Woonoona High School.

#### **4.4.8 Bellambi Gully**

The water quality in Bellambi Gully is characterised by elevated pH, conductivity, BOD, COD, ammonia, suspended solids, nutrients, copper and zinc. Faecal coliform levels generally exceed the primary recreational contact guidelines. The creek receives runoff and discharges from Bellambi Coal Company, Russel Vale waste disposal area and urban development. The low macroinvertebrate diversity is indicative of an urbanised catchment, water quality problems and/or loss of riparian habitat.

The catchment has been affected by the loss of fauna and riparian habitat through clearing and urban development but it still provides potential habitat for threatened amphibians (Green and Golden Bell Frog and Red-crowned Toadlet) and threatened birds (Australasian Bittern, Black Bittern and foraging habitat for owls).

The potential decline and/or weed invasion of the Coastal Saltmarsh EEC, plus the conservation of the mangroves, are of importance to the continued ecological functioning of the estuary.

The estuary banks are unstable and/or eroding in numerous places, including immediately upstream of the rail crossing, Gladstone Street and Brompton Road, upstream and downstream of the footbridge, and immediately downstream of the Princes Highway and the Northern Distributor.

#### **4.4.9 Bellambi Lagoon**

The water quality at Bellambi Lagoon is generally worse at the northern end than at its mouth, with low dissolved oxygen levels possibly related to stormwater discharges at the northern end. Elevated dissolved oxygen levels near the entrance might be associated with the presence of algal blooms, which oxygenate the water during the day, but can cause severe oxygen depletion during the night or when the bloom dies and decomposes. Nutrients including total nitrogen, ammonia and phosphorus were also elevated, together with the heavy metals, copper and zinc. Faecal coliform levels generally exceed the primary recreational contact guidelines in the northern part of the lagoon.

Bellambi Lagoon has the highest level of biodiversity of the creeks studies, and includes Coastal Saltmarsh, Swamp Oak Floodplain and Bangalay Sand Forest EECs, potential habitat for threatened

amphibians (Green and Golden Bell Frog), threatened birds (Australasian Bittern, Black Bittern and foraging habitat for owls), and hollow bearing trees and potential foraging habitat for a variety of birds and mammals. The Lagoon also provides limited seagrass habitat, which is an important habitat nursery and breeding for fish.

Issues of particular concern for the continued conservation and improvement of the high biodiversity values include weed infestation, loss of natural flora and fauna, loss of habitat for endangered fauna species, introduced fauna preying on native fauna, water quality and macroalgae impacts on seagrasses, water quality impacts from urban development, impacts from inappropriate recreational activities, and bank stability issues.

Bellambi Lagoon is a highly valued Aboriginal site. Measures to conserve the cultural heritage value of the area could include minimising dune erosion, and reducing the damage caused by inappropriate recreational activities, such as the use of trail bikes, setting of bushfires, and the creation and widening of informal tracks.

Upstream reaches of the creek are highly constrained by development between the Princes Highway and the Northern Distributor and are likely to be experiencing moderate to high degrees of channel instability. The northern bank of the entrance is suffering severe erosion from wind and wave action, and efforts to minimise this would be beneficial to the long term conservation of the Aboriginal middens in that area.

#### **4.4.10 Tom Thumb Lagoon**

The water quality at Tom Thumb Lagoon is poor, and characterised by elevated suspended solids, likely to be a natural consequence of tidal movements, and elevated nitrate levels, possibly associated with leachate from the decommissioned landfill site at Greenhouse Park. Elevated levels of all heavy metals (except arsenic) exceed the ANZECC guideline trigger values, and are likely to be associated with long-term contamination of sediments by the surrounding heavy industry. Indirect pollution from airborne contaminants also impact upon the estuary system, (Eco Logical; 2006), and the system also receives stormwater from Wollongong CBD. Although faecal coliform levels are relatively good, the lagoon does receive sewage overflows during wet weather.

Tom Thumb Lagoon has areas of Coastal Saltmarsh and Swamp Oak Floodplain EECs; the Swamp Oak Forest provides potential foraging habitat for a variety of birds and mammals. The lagoon also has potential habitat for the threatened Green and Golden Bell Frog. The extensive mangrove community provides an important nursery habitat for important fish species, but in some areas is competing with the Coastal Saltmarsh EEC and may therefore require active management to prevent the EEC being adversely affected.

Issues of particular concern for the continued conservation and improvement of the biodiversity values include weed infestation, management of habitat for endangered fauna species, introduced fauna preying on native fauna, and water quality impacts from urban and industrial development.

The banks of the lagoon are generally stable, with no moderate to highly active bank erosion. However, scour and channelisation is evident across the floor of the saltmarsh flat in the western arm and would benefit from monitoring.



## 5. Objectives for Future Management

### 5.1 Identification

Wollongong City Council has established an Estuary Management Committee (EMC) to assist in the preparation and implementation of Estuary Management Plans in accordance with the NSW Government's Estuary Management Policy.

An Estuary Processes Study (EPS) has been undertaken for the ten small estuaries to investigate their terrestrial and aquatic ecological values, plus their geomorphology and hydrodynamics. The EPS also reviewed available water quality data, and incorporated preliminary consultation with interested parties (GHD, 2007).

The Estuary Management Committee has agreed to proceed to the development of an Estuary Management Study and Preparation of an Estuary Management Plan, to build on the information gathered through the EPS, which identified a series of issues and knowledge gaps, and proposed further studies and management actions.

Council, DECC (formerly DNR) and GHD prepared a preliminary series of draft management objectives for consideration during this study. The draft objectives were presented and discussed at a Councillor briefing on 25 June 2007 and at a meeting of the Estuary Management Committee on 28 June 2007. Comments on the draft objectives were taken into consideration during finalisation of the management objectives, which were subsequently adopted by the Estuary Management Committee. The adopted management objectives are presented in Section 5.2.

### 5.2 Adopted Objectives

The Estuary Management Committee adopted the management objectives detailed in Table 5.1.

**Table 5.1 Draft Management Objectives**

Draft Management Objective	Description
<b>Habitat and Species Conservation</b>	Protect, retain and improve existing habitat of value (EECs, habitat for threatened species, aquatic habitat), rehabilitate areas of degraded habitat, and improve habitat connectivity where appropriate and achievable. Regenerate aquatic, foreshore and riparian vegetation communities.
<b>Water Quality</b>	Maintain and improve existing water quality such that it supports a healthy aquatic ecosystem and allows appropriate recreational use and visual amenity.
<b>Sedimentation and Erosion</b>	Minimise estuary sedimentation and erosion caused by human activities and flooding throughout the freshwater and estuarine reaches of the catchment.
<b>Cultural Heritage</b>	Protect and retain areas of Aboriginal and European cultural heritage within and adjacent to the estuaries.



Draft Management Objective	Description
<b>Sustainable Development</b>	Promote ecologically sustainable development, recognising the finite capacity of estuarine ecosystems. Recognise and manage or mitigate the impacts of inappropriate development.
<b>Recreation</b>	Encourage and provide facilities for appropriate recreational use of the estuary, foreshore and catchment, while protecting and improving ecosystem viability.
<b>Flooding</b>	Minimise the impact of flooding on existing and future development in accordance with Council's Floodplain Risk Management Plans, while maintaining and, where possible, improving ecosystem viability.
<b>Visual Amenity</b>	Maintain or improve the natural integrity and visual experience of the landscape from the waterway and from catchment vantage points.
<b>Estuary Entrance</b>	Identify and, where appropriate, implement an appropriate opening regime for each estuary to address flooding, water quality and ecological concerns.
<b>Information and Communications</b>	Involve local communities in estuary management through education, awareness raising, consultation and participation.
<b>Implementation, Monitoring and Review</b>	Implement the EMP to achieve identified performance targets and monitor implementation to audit performance and adapt management strategies where necessary.

## 6. Development and Assessment of Future Management Strategies

### 6.1 Identification of management strategies

Management strategies and actions were developed to achieve and address each management objective. The strategies and actions were developed through a consultative process with Councillors, Council, DECC and the EMC, taking into consideration the issues raised through the community consultation process.

### 6.2 Description of management strategies

The draft management strategies and associated draft management actions are detailed in Tables 6.1-6.11. Each management action has been assigned a unique number to allow cross referencing between tables. Some management actions address more than one management objective or strategy and this is indicated by duplication of the management action in the relevant tables.

**Table 6.1 Draft Management Strategies and Actions – Habitat and Species Conservation**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Protect key estuarine aquatic and intertidal habitats through the development control and statutory planning processes	1	Ensure estuaries are appropriately zoned (prohibiting certain development types), dedicated and/or reserved, and appropriate development controls are implemented. Review all zonings and update to reflect the new LEP template zonings.	All estuaries	WCC	H In progress
Protect key estuarine aquatic and intertidal habitats through the development control and statutory planning processes	2	Where alternative siting for a development is not appropriate, adopt the principle of environmental compensation in the approval process for any activity that causes unavoidable damage to any estuarine habitat or catchment habitat that is of importance to the estuary.	All estuaries	WCC	L
Protect key estuarine aquatic and intertidal habitats through the development control and statutory planning processes	3	Review public ownership of foreshore and riparian areas whenever opportunities arise through rezoning, development approvals or acquisition (including like-for-like contributions from developers/landowners)	All estuaries	WCC	H
Protect key estuarine aquatic and intertidal habitats through the development control and statutory planning processes	4	Introduce appropriate zoning or an LEP clause requiring consent from Council for any development within reserves and buffer zones, except for fencing, revegetation or any works contained in an Estuary Management Plan and prohibiting certain development types altogether. Require development consent for all land uses that potentially have adverse impacts on estuarine ecosystems and prohibit development with impacts that cannot be reasonably mitigated.	All estuaries	WCC	H In progress
Protect key estuarine aquatic and intertidal habitats through the development control and statutory planning processes	5	Adopt riparian objectives and control measures as detailed in Council's Riparian Development Control Plan.	All estuaries	WCC, SRCMA	H
Protect key estuarine aquatic and intertidal habitats through the development control and statutory planning processes	6	Negotiate property vegetation plans and property management plans with owners of land with vegetation communities and/or ecological communities of significant conservation value.	All estuaries	WCC, SRCMA	H
Protect, and enhance access to, fish breeding, nursery or recruitment habitat	7	Investigate the potential impacts on estuarine ecology and water quality of barriers to fish passage, and modify/remove as appropriate.	TTL, SL	WCC, CVA, DPI	H
Protect, and enhance access to, fish breeding, nursery or recruitment habitat	8	Carry out snag removal only where risks to public safety occur.	All estuaries	WCC, DPI	L
Protect, and enhance access to, fish breeding, nursery or recruitment habitat	9	Investigate and protect areas of valuable fish nursery habitat (seagrasses and mangroves), including an assessment of the implications of water quality and macroalgae on seagrasses.	BL, TTL	WCC, CVA, DPI	H
Improve/restore aquatic, foreshore and riparian vegetation	10	Restrict or control access to sensitive estuarine habitats whilst providing appropriate access points for authorised users.	All estuaries	WCC, CVA, SRCMA	M
Improve/restore aquatic, foreshore and riparian vegetation	11	Remove non-native and noxious species and revegetate and regenerate using local native species.	All estuaries	WCC, CVA, SRCMA	H

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Improve/restore aquatic, foreshore and riparian vegetation	12	Protect mangroves from human access/trampling and weed invasion.	BG, BL, TTL	WCC, CVA, SRCMA	M
Improve/restore aquatic, foreshore and riparian vegetation	13	Consider the impacts of climate change (particularly sea level rise) in the assessment of proposed developments, and when identifying and prioritising sites for regeneration works.	All estuaries	WCC, SRCMA	L
Improve stream bank stability	14	Establish and maintain well-vegetated riparian zones using appropriate local native riparian vegetation in accordance with floodplain management objectives and Sydney Water infrastructure.	StoC, FC, WC	WCC, SRCMA	H
Improve stream bank stability	15	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	FC, SL WC, CC, BG	WCC, SRCMA	H
Monitor feral animal populations	16	Investigate and implement actions to reduce feral species, if warranted.	BL, TTL	WCC	L
Manage pedestrian and vehicular access to sensitive riparian and aquatic habitats	17	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	StaC, BG, BL, HC	WCC, SRCMA	M
Manage pedestrian and vehicular access to sensitive riparian and aquatic habitats	18	Relocate or control access to existing informal paths to minimize impacts on the sensitive vegetation or habitats.	BL	WCC, SRCMA	H
Manage pedestrian and vehicular access to sensitive riparian and aquatic habitats	19	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc.	All estuaries	WCC, SRCMA	H
Protect the potential riparian and in-stream habitat for the Red Crowned Toadlet (in the freshwater reaches)	20	Protect potential riparian habitat for the Red Crowned Toadlet by minimising disturbance to the upper reaches of the creeks	HC, StaC, BG, BL	WCC, DECC, SRCMA	M
Protect and enhance the potential riparian habitat for the Green and Golden Bell Frog	21	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	HC, StaC, CC, BG, BL, TTL	WCC, CVA, DECC, SRCMA	M
Protect and enhance the potential riparian habitat for the Green and Golden Bell Frog	22	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing vegetation.	HC, StaC, CC, BG, BL, TTL	WCC, CVA, DECC, SRCMA	M
Protect and enhance the potential riparian habitat for the Green and Golden Bell Frog	23	Investigate, and where possible implement, measures to control or eradicate the introduced Mosquito fish.	FC, CC, BG, BL	WCC, DECC	L
Protect the potential foraging habitat for threatened birds (Sooty Owl, Powerful Owl, Barking Owl).	24	Further investigate the importance of the potential habitat to the species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	HC, StaC, BG, BL	WCC, DECC	H

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Protect the potential foraging habitat for threatened birds (Sooty Owl, Powerful Owl, Barking Owl).	25	Retain large stands of native and riparian vegetation, identify and protect any hollow-bearing trees and retain younger recruitment trees to replace older trees in the long-term, through implementation of DCPs and DA approval process.	HC, StaC, BG, BL	WCC, DECC	H In progress
Protect the potential habitat for the threatened Sooty Oystercatcher	26	Reduce disturbance to coastal feeding, nesting and roosting areas by implementing a protection zone around it (500m radius), and restricting beach-combing, fishing, dog-walking, horse-riding, 4WD vehicles and other disturbing activities in the immediate vicinity of the potential habitat.	StaC	WCC, DECC	L
Protect the potential habitat for all species of threatened shorebirds and migratory waders.	19	Erect interpretative signs to provide information to visitors and residents of the importance of the potential habitat for all species of threatened shorebirds and migratory waders.	All estuaries	WCC, DECC	H
Protect the potential habitat for threatened birds (Australasian Bittern and Black Bittern).	24	Further investigate the importance of the potential habitat to the species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	BG, BL	WCC, DECC	H
Protect the potential habitat for threatened birds (Australasian Bittern and Black Bittern).	27	Protect and manage potential habitat by creating buffer zones around it (with vegetation or through maintenance of high water levels) to minimise risk of human disturbance.	BG, BL	WCC, DECC, SRCMA	H
Protect the potential habitat for threatened birds (Australasian Bittern and Black Bittern).	19	Erect interpretative signs to provide information to visitors and residents of the importance of the potential habitat for threatened birds (Australasian Bittern and Black Bittern).	BG, BL	WCC, DECC	H
Protect the potential habitat for threatened birds (Australasian Bittern and Black Bittern).	28	Monitor the presence, density, levels of activity, and potential impacts of feral animals, in particular foxes and cats, on threatened Bittern species	BG, BL	WCC, DECC	L
Protect and enhance remnant areas of Coastal Saltmarsh EEC	29	Investigate and manage water quality and hydrological impacts on saltmarsh	HC, CC, BG, BL, TTL	WCC, DECC, SRCMA	H (TTL) & in progress M (Others)
Protect and enhance remnant areas of Coastal Saltmarsh EEC	30	Investigate and manage competition between mangroves and saltmarsh in consultation with DPI.	TTL	WCC, CVA, DPI, DECC	H In progress
Protect and enhance remnant areas of Coastal Saltmarsh EEC	31	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	HC, CC, BG, BL, TTL	WCC, CVA, DPI, SRCMA	L
Protect and enhance remnant areas of Coastal Saltmarsh EEC	32	Allow areas of saltmarsh to regenerate naturally where possible.	HC, CC, BG, BL, TTL	WCC, CVA, DPI, SRCMA	L

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Protect and enhance remnant areas of Coastal Saltmarsh EEC	33	Protect saltmarsh from disturbance through provision of signage and active management.	HC, CC, BG, BL, TTL	WCC, CVA, DPI, SRCMA	M
Protect and enhance remnant areas of Coastal Saltmarsh EEC	10	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	HC, CC, BG, BL, TTL	WCC, CVA, DPI	M
Protect and enhance remnant areas of Coastal Saltmarsh EEC	17	Minimise human disturbance to Coastal Floodplain EEC by relocating and/or formalizing pedestrian beach/estuary access routes.	HC, CC, BG, BL, TTL	WCC, CVA, DPI	H
Protect and enhance remnant areas of Coastal Saltmarsh EEC	19	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC.	HC, CC, BG, BL, TTL	WCC, DPI	H
Protect and enhance remnant areas of Coastal Saltmarsh EEC	34	Implement weed control programs to prevent and control infestation of Endangered Ecological Communities (EECs).	HC, CC, BG, BL, TTL	WCC, CVA, DPI, SRCMA	H In progress
Protect and enhance remnant areas of the Swamp Oak Floodplain EEC	35	Protect the swamp oak floodplain habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	StaC, BL, TTL	WCC, DECC	H
Protect and enhance remnant areas of the Swamp Oak Floodplain EEC	36	Undertake restoration including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users.	StaC, BL, TTL	WCC, CVA, DECC	M
Protect and enhance remnant areas of the Swamp Oak Floodplain EEC	37	Promote public involvement in restoration and bush regeneration activities.	StaC, BL, TTL	WCC, CVA, DECC	M
Protect and enhance remnant areas of the Swamp Oak Floodplain EEC	19	Erect interpretative signs to provide information to visitors and residents of the importance of the Swamp Oak Floodplain EEC.	StaC, BL, TTL	WCC, CVA, DECC	H
Protect and enhance remnant areas of the Swamp Oak Floodplain EEC	10	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Swamp Oak Floodplain EEC.	StaC, BL, TTL	WCC, DECC	M
Protect and enhance remnant areas of the Swamp Oak Floodplain EEC	17	Minimise human disturbance to Swamp Oak Floodplain EEC by relocating and/or formalizing pedestrian beach/estuary access routes.	StaC, BL, TTL	WCC, DECC	M

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Protect and enhance remnant areas of the Swamp Oak Floodplain EEC	34	Implement weed control programs to prevent infestation of Endangered Ecological Communities (EECs).	StaC, BL, TTL	WCC, CVA, DECC	H (ongoing)
Protect and enhance remnant areas of the Bangalay Sand Forest EEC	38	Protect the Bangalay Sand Forest habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	BL	WCC, DECC, SRCMA	H
Protect and enhance remnant areas of the Bangalay Sand Forest EEC	36	Undertake restoration of Bangalay Sand Forest EEC, including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users..	BL	WCC, DECC	M
Protect and enhance remnant areas of the Bangalay Sand Forest EEC	39	Promote public involvement in restoration and bush regeneration activities.	BL	WCC, DECC, SRCMA	M
Protect and enhance remnant areas of the Bangalay Sand Forest EEC	19	Erect educational signs to provide information to visitors and residents of the importance of the Bangalay Sand Forest EEC.	BL	WCC, DECC	H
Protect and enhance remnant areas of the Bangalay Sand Forest EEC	10	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Bangalay Sand Forest EEC.	BL	WCC, DECC	M
Protect and enhance remnant areas of the Bangalay Sand Forest EEC	17	Minimise human disturbance to Bangalay Sand Forest EEC by relocating and/or formalizing pedestrian beach/estuary access routes.	BL	WCC, DECC	H
Educate the community on the value of estuarine habitats and how they can contribute to their protection.	40	Initiate community awareness programs that highlight the presence of threatened species populations and catchment management approaches to improving stormwater quality, habitat retention and management.	All estuaries	WCC, DECC, SRCMA	H
Educate the community on the value of estuarine habitats and how they can contribute to their protection.	41	Provide ongoing support and opportunities for the community to participate in restoration and management of aquatic, wetland and wildlife habitats (eg. through WCC's Bushcare program).	All estuaries	WCC, CVA, DECC, DPI, SRCMA	M
Educate Council staff to prevent damage caused by mowing sensitive habitats and vegetation.	42	Erect appropriate barriers around foreshore vegetation to prevent mowing by Council outdoor staff.	All except TTL	WCC	H
Educate Council staff to prevent damage caused by mowing sensitive habitats and vegetation.	43	Erect signage adjacent to sensitive habitats to inform Council staff not to mow/slash the vegetation	All except TTL	WCC	H



Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Educate Council staff to prevent damage caused by mowing sensitive habitats and vegetation.	44	Establish Standard Operating Procedures for Council staff to follow to prevent mowing/slashing of sensitive vegetation (including EECs), inappropriate use of herbicides/pesticides, etc, incorporating maps or photos of the sensitive habitats. Investigate Council's control over inappropriate aerial herbicide spraying undertaken by the Illawarra District Noxious Weed Authority (IDNWA).	All estuaries	WCC, IDNWA	H

Notes: <sup>1</sup> HC - Hargraves Creek, StaC - Stanwell Creek, StoC - Stoney Creek, FC - Flanagans Creek, SC - Slacky Creek, WC - Whartons Creek, CC - Collins Creek, BG - Bellambi Gully, BL - Bellambi Lagoon, TTL - Tom Thumb Lagoon

<sup>2</sup> H – High Priority (Rank 1-100), M – Medium Priority (Rank 101-200), L – Low Priority (Rank 201+)

**Table 6.2 Draft Management Strategies and Actions – Water Quality**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Adopt appropriate water quality standards	45	Develop and adopt water quality standards (as per ANZECC 2000) for the estuary to identify appropriate standards for aquatic ecosystem health.	All estuaries	WCC	H In progress
Develop and adopt a system of cumulative impact assessment for land use planning and development control.	46	Calculate pollutant inventories and budgets for existing land uses and prepare land and water capability assessments to establish total allowable pollutant loads and other relevant loads or factors.	All estuaries	WCC	H
Strictly control water quality impacts of development.	47	Prepare and adopt a Soil and Water Management Policy that requires submission of a Construction Environmental Management Plan (including a Soil and Water Management Plan) with a Development Application setting out how erosion and sediment control, water quality and water quantity will be managed during both the construction and operational stages to achieve the required water quality standards.	All estuaries	WCC	M In progress
	48	Incorporate in the Soil and Water Management Policy a condition that pre- and post-development monitoring be undertaken to prove compliance with the standards at the developer's cost.	All estuaries	WCC	H
Strictly control water quality impacts of development.	49	Establish water quality standards for stormwater runoff from new development considering the estuary's temporal response to pollutant inputs (daily, weekly or monthly) and within the framework of the cumulative impact assessment.	All estuaries	WCC	M
Strictly control water quality impacts of development.	50	Adopt water-sensitive urban design principles, using the LEP or a separate LGA-wide DCP.	All estuaries	WCC	H In progress
Strictly control water quality impacts of development.	51	Permit development on unsewered urban or rural lots only where there is sufficient area of suitable soil away from drainage lines to satisfactorily dispose of septic effluent on site.	All estuaries	WCC	M In progress
Strictly control water quality impacts of development.	52	Prepare Stormwater Management Plans for existing developed areas within the framework of the cumulative impact assessment.	All estuaries	WCC	H
Strictly control water quality impacts of development.	53	Retrofit existing urban development with stormwater treatment measures such as trash racks, gross pollutant traps and wetlands (where space permits).	All estuaries	WCC, SRCMA	M
Strictly control water quality impacts of development.	54	Regularly inspect and audit construction sites to monitor compliance with water quality criteria attached to the development consent.	All estuaries	WCC	M
Strictly control water quality impacts of development.	55	Regularly inspect and maintain stormwater treatment devices to ensure continued effectiveness.	All, and particularly TTL	WCC	H

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Strictly control water quality impacts of development.	56	Investigate reported water pollution events to determine and rectify the source. Investigate and rectify source of pollution of a small ephemeral tributary of Hargraves Creek, which has large volumes of bubbles and a grey colouration during rainfall periods. Investigate the potential impact of the impoundment of Stoney Creek on water quality, hydrology and ecology.	HC, StoC	WCC	H
Investigate and quantify foreshore pollutant problem	57	Conduct a pollutant audit and remediate inappropriate practices.	All estuaries	WCC	L In progress
Improve water quality through catchment modifications and improved control and monitoring of point source discharges	7	Investigate the potential impacts on estuarine ecology and water quality of barriers to fish passage, and modify/remove as appropriate.	SL, TTL	WCC, CVA, DPI	H
Improve water quality through catchment modifications and improved control and monitoring of point source discharges	58	Identify and map on Council's GIS the location of all point source discharges to the creeks.	All estuaries	WCC	L
Improve water quality through catchment modifications and improved control and monitoring of point source discharges	59	Include acid sulphate soil provisions in LEP. Identify any existing acid sulphate drainage, remediate and, if required, prepare a plan for ongoing management.	All estuaries	WCC	H
Improve sewerage infrastructure and performance.	60	Develop SCAMPS in all catchments where faecal contamination is an issue, and address capacity of systems.	All estuaries	SWC	M
Improve sewerage infrastructure and performance.	61	Require all residents to connect to the Stanwell Park Sewerage Scheme.	HC, StaC, StoC	WCC	H
Educate the local community	62	Educate the community on environmentally responsible practices around the house that protect water quality by developing a brochure for distribution to all residents, recommending measures including: composting grass clippings; using organic rather than synthetic fertilisers; applying fertiliser sparingly and according to soil requirements; vegetating bare soil areas; using phosphate-free detergents; washing cars on grass; capturing pet droppings; and not dumping domestic refuse, including grass clippings, on the foreshores and riverbanks or in the bush.	All estuaries	WCC, SRCMA	H In progress
Educate the local community	63	Educate specific industry groups and developers of best management practices for minimising polluted runoff.	All estuaries	WCC, SRCMA	M
Implement a program of estuary water quality monitoring to provide Council with data on which to base management decisions.	64	Adopt and adapt the Beach Watch recreational water quality monitoring program (based on NHMRC 1990 and ANZECC 2000 criteria), and regularly monitor estuary water quality against these parameters. Publish the results on signage near the estuaries and on Council's website.	All except TTL	WCC	H
Implement a program of estuary water quality monitoring to provide Council with data on which to base management decisions.	65	Monitor estuarine water and sediment quality and ecosystem health, and catchment water and sediment quality, in accordance with the Monitoring Plan in Chapter 8 of the EMP.	All estuaries	WCC	H

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Implement a program of estuary water quality monitoring to provide Council with data on which to base management decisions.	66	Erect signage near the estuary entrance to inform the community about potential water quality problems and associated health risks from primary and secondary recreational contact, particularly after rainfall.	All except TTL	WCC	H
Implement a program of estuary water quality monitoring to provide Council with data on which to base management decisions.	67	Investigate options to mitigate water quality impacts from the sewer overflow upstream of TTL and implement when possible.	TTL	SWC, WCC	M In progress
Monitor the potential water quality impact of Industry	68	Monitor impacts associated with leachate discharges from the old landfills at TTL and Collins Creek.	CC, TTL	WCC	H In progress at TTL
Monitor the potential water quality impact of Industry	69	Undertake a desktop assessment of existing water quality discharge data to investigate the potential for water quality improvement in TTL as a result of the closure of the Tin Mill.	TTL	WCC	L

Notes: <sup>1</sup> HC - Hargraves Creek, StaC - Stanwell Creek, StoC - Stoney Creek, FC - Flanagans Creek, SC - Slacky Creek, WC - Whartons Creek, CC - Collins Creek, BG - Bellambi Gully, BL - Bellambi Lagoon, TTL - Tom Thumb Lagoon

<sup>2</sup> H – High Priority (Rank 1-100), M – Medium Priority (Rank 101-200), L – Low Priority (Rank 201+)

**Table 6.3 Draft Management Strategies and Actions – Sedimentation and Erosion**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Control erosion during development activities	47	Prepare and adopt a Soil and Water Management Policy that requires submission of a Construction Environmental Management Plan (including a Soil and Water Management Plan) with a Development Application setting out how erosion and sediment control, water quality and water quantity will be managed during both the construction and operational stages to achieve the required water quality standards.	All estuaries	WCC	M In progress
Control erosion during development activities	54	Regularly inspect and audit construction sites to monitor compliance with water quality criteria attached to the development consent.	All estuaries	WCC	M
Protect and restore eroding banks.	5	Adopt riparian objectives and control measures as detailed in Council's Riparian Development Control Plan.	All estuaries	WCC	H
Protect and restore eroding banks.	70	Stabilise dunes near the estuary entrance in accordance with best management practice.	FC, WC, HC, BL	WCC	H (BL) M (Others)
Install erosion and sedimentation control measures.	53	Retrofit existing urban development with stormwater treatment measures such as trash racks, gross pollutant traps and wetlands (where space permits).	All estuaries	WCC	M
Install erosion and sedimentation control measures.	55	Regularly inspect and maintain stormwater treatment devices to ensure continued effectiveness.	All estuaries	WCC	H
Manage areas of erosion to reduce sediment load to the catchment	71	Investigate, verify and rectify potential erosion sites in upstream catchments, with priority given to Bellambi Gully and Bellambi Lagoon.	BG, BL, HC, FC, StoC, SL, WC, CC	WCC, SRCMA	M
Manage areas of erosion to reduce sediment load to the catchment	72	Undertake an erosion and sedimentation survey (including catchment, in-stream and foreshores) assessing sediment yield of sources, sediment quality and rate of infilling. Remediate sources of high risk to the estuary.	All estuaries	WCC, SRCMA	M
Manage areas of erosion to reduce sediment load to the catchment	73	Investigate alternative methods to repair Lower Beach Road, Stanwell Park, to minimise erosion of material and deposition in Stanwell Creek. Alternatively, re-design and resurface the road to restore integrity and stability.	StaC	WCC	H

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Manage areas of erosion to reduce sediment load to the catchment	74	Investigate and if necessary de-silt Stanwell Creek immediately downstream of the causeway to restore it's original profile and depth (following finalisation of repairs/reconstruction of Lower Coast Road).	StaC	WCC	H
Manage areas of erosion to reduce sediment load to the catchment	75	Monitor minor erosion in the vicinity of the footbridge to ensure it does not worsen and impact the footbridge in the future. Remediate erosion if considered necessary.	BG	WCC, SRCMA	L
Implement site specific erosion measures	76	Fence area of bank erosion H1 (refer Figures F1-F10 in the EPS report) and revegetate the understorey vegetation to reduce the extent and rate of erosion.	HC	WCC, SRCMA	M
Implement site specific erosion measures	77	Establish a fenced revegetated riparian zone at area of bank erosion H2 (refer Figures F1-F10 in the EPS report) to reduce the extent and rate of erosion.	HC	WCC, SRCMA	M
Implement site specific erosion measures	78	Formalise the beach access and revegetate at area of erosion H3 (refer Figures F1-F10 in the EPS report).	HC	WCC, SRCMA	M
Implement site specific erosion measures	79	Provide rock toe protection at area of bank erosion SW1 (refer Figures F1-F10 in the EPS report), and revegetate upper bank with understorey and shrub species. Extend downstream through the minimally active zone.	StaC	WCC, SRCMA	M
Implement site specific erosion measures	80	Extend the existing rock toe protection downstream to area of bank erosion SW2 (refer Figures F1-F10 in the EPS report). Provide revegetation and fencing to control access along the downstream section.	StaC	WCC, SRCMA	M
Implement site specific erosion measures	81	Provide rock toe protection at area of bank erosion S1 (refer Figures F1-F10 in the EPS report), re-shape the upper bank, and revegetate.	SL	WCC, SRCMA	H
Implement site specific erosion measures	82	Provide rock toe protection at area of bank erosion S2 (refer Figures F1-F10 in the EPS report), or re-shape, to minimize erosion. Revegetate to improve riparian vegetation corridor and increase bank stability.	SL	WCC, SRCMA	H
Implement site specific erosion measures	83	Supplement the erosion protection (gabion baskets) provided near the entrance to the estuary with revegetation.	WC	WCC, SRCMA	M
Restrict access to areas prone to erosion	84	Restrict access to, and revegetate, the left bank between the entrance to Bulli Beach Holiday Park and the footbridge.	WC	WCC, SRCMA	M
Restrict access to areas prone to erosion	85	Formalise a beach access on the right bank and revegetate disturbed areas to reduce erosion.	BL	WCC, SRCMA	M
Educate the community regarding erosion and mitigation measures	62	Educate the community on environmentally responsible practices around the house that protect water quality by developing a brochure for distribution to all residents, recommending measures including: composting grass clippings; using organic rather than synthetic fertilisers; applying fertiliser sparingly and according to soil requirements; vegetating bare soil areas; using phosphate-free detergents; washing cars on grass; capturing pet droppings; and not dumping domestic refuse, including grass clippings, on the foreshores and riverbanks or in the bush.	All estuaries	WCC	H In progress



Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Educate the community regarding erosion and mitigation measures	19	Provide signage to educate the community about the damage caused by inappropriate activities and access, including the illegal removal of beach sand.	All estuaries	WCC	H

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<sup>2</sup> H – High Priority (Rank 1-100), M – Medium Priority (Rank 101-200), L – Low Priority (Rank 201+)

**Table 6.4 Draft Management Strategies and Actions – Cultural Heritage**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Identify and protect sites of significant Aboriginal and European heritage	86	Protect sites through the LEP.	BL	WCC, DECC	H In progress
Identify and protect sites of significant Aboriginal and European heritage	87	Undertake stabilisation works on the northern bank of Bellambi Lagoon entrance to prevent/minimise further erosion and encroachment into an area of Aboriginal heritage.	BL	WCC, DECC, SRCMA	H
Identify and protect sites of significant Aboriginal and European heritage	88	Replace existing temporary fencing with permanent fencing to discourage human disturbance of particularly sensitive areas of the dunes and heritage area.	BL	WCC, DECC, SRCMA	H
Identify and protect sites of significant Aboriginal and European heritage	19	Provide signage to educate the community about the damage caused to Aboriginal heritage through inappropriate activities and access.	BL	WCC, DECC	H
Educate the community about the significance of Aboriginal and European heritage sites.	89	Erect interpretative signage at the beach reserve relating to Aboriginal heritage significance.	BL	WCC, DECC	H
Educate the community about the significance of Aboriginal and European heritage sites.	90	Investigate sites and areas of potential cultural heritage significance (Aboriginal and European, including the campsites near Stanwell Creek) and protect as necessary.	All estuaries	WCC, DECC	H

Notes: <sup>1</sup> HC - Hargraves Creek, StaC - Stanwell Creek, StoC - Stoney Creek, FC - Flanagans Creek, SC - Slacky Creek, WC - Whartons Creek, CC - Collins Creek, BG - Bellambi Gully, BL - Bellambi Lagoon, TTL - Tom Thumb Lagoon

<sup>2</sup> H – High Priority (Rank 1-100), M – Medium Priority (Rank 101-200), L – Low Priority (Rank 201+)

**Table 6.5 Draft Management Strategies and Actions – Sustainable Development**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Manage the planning system to achieve sustainable development, reflecting community values and awareness of the importance of estuaries.	1	Ensure estuaries are appropriately zoned (prohibiting certain development types), dedicated and/or reserved, and appropriate development controls are implemented. Review all zonings and update to reflect the new LEP template zonings.	All estuaries	WCC	H In progress
	4	Introduce appropriate zoning or an LEP clause requiring consent from Council for any development within reserves and buffer zones, except for fencing, revegetation or any works contained in an Estuary Management Plan and prohibiting certain development types altogether. Require development consent for all land uses that potentially have adverse impacts on estuarine ecosystems and prohibit development with impacts that cannot be reasonably mitigated.	All estuaries	WCC	H In progress
Manage the planning system to achieve sustainable development, reflecting community values and awareness of the importance of estuaries.	91	Adopt a precautionary approach of accepting a lower level of risk (ie. a wider safety margin) for managing existing and proposed land and waterway uses affecting highly valued environmentally sensitive components of the estuarine ecosystem.	All estuaries	WCC	M
Manage the planning system to achieve sustainable development, reflecting community values and awareness of the importance of estuaries.	13	Consider the impacts of climate change (particularly sea level rise) in the assessment of proposed developments, and when identifying and prioritising sites for regeneration works.	All estuaries	WCC	L
Manage the planning system to achieve sustainable development, reflecting community values and awareness of the importance of estuaries.	59	Include acid sulphate soil provisions in LEP. Identify any existing acid sulphate drainage, remediate and, if required, prepare a plan for ongoing management.	All estuaries	WCC	H In progress
Manage the planning system to achieve sustainable development, reflecting community values and awareness of the importance of estuaries.	5	Adopt riparian objectives and control measures as detailed in Council's Riparian Development Control Plan.	All estuaries	WCC	H
Manage the planning system to achieve sustainable development, reflecting community values and awareness of the importance of estuaries.	92	Require that a Local Environmental Study be prepared for a major LEP or rezoning proposal for any area within or adjoining an estuary. The LES should consider potential impacts on estuarine values including the ecosystem, threatened species, water quality, cultural heritage, foreshore and estuary access and usage, population levels with tourist influx, public amenity, fishing and acid sulphate soils.	All estuaries	Proponent	H

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Manage the planning system to achieve sustainable development, reflecting community values and awareness of the importance of estuaries.	46	Calculate pollutant inventories and budgets for existing land uses and prepare land and water capability assessments to establish total allowable pollutant loads and other relevant loads or factors.	All estuaries	WCC	H
Manage the planning system to achieve sustainable development, reflecting community values and awareness of the importance of estuaries.	49	Establish water quality standards for stormwater runoff from new development considering the estuary's temporal response to pollutant inputs (daily, weekly or monthly) and within the framework of the cumulative impact assessment.	All estuaries	WCC	M

Notes: <sup>1</sup> HC - Hargraves Creek, StaC - Stanwell Creek, StoC - Stoney Creek, FC - Flanagan's Creek, SC - Slacky Creek, WC - Whartons Creek, CC - Collins Creek, BG - Bellambi Gully, BL - Bellambi Lagoon, TTL - Tom Thumb Lagoon

<sup>2</sup> H – High Priority (Rank 1-100), M – Medium Priority (Rank 101-200), L – Low Priority (Rank 201+)

**Table 6.6 Draft Management Strategies and Actions – Recreation**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Rationalise public and private facilities within and adjacent to the estuaries.	93	Survey public foreshore structures and assess whether the location and extent is appropriate. Require the removal of unauthorised private foreshore structures where they cause a navigation hazard, are unsafe, or exacerbate erosion.	All estuaries	WCC	L
Rationalise public and private facilities within and adjacent to the estuaries.	94	Based on the access and demand survey, provide facilities such as parking, litter collection, amenities and walking trails.	All estuaries	WCC	L
Improve the availability of public recreational space through the acquisition, rezoning and sensitive management of appropriate areas of foreshore land.	95	Ensure sufficient and appropriate foreshore land continues to be reserved for access and facilities.	All estuaries	WCC	M
Improve the availability of public recreational space through the acquisition, rezoning and sensitive management of appropriate areas of foreshore land.	96	Maximise public ownership and appropriate access to Council and Crown foreshore land.	All estuaries	WCC	L
Improve the availability of public recreational space through the acquisition, rezoning and sensitive management of appropriate areas of foreshore land.	97	Classify Council-owned land with open space or conservation value as community land under the Local Government Act.	All estuaries	WCC	L In progress
Improve the availability of public recreational space through the acquisition, rezoning and sensitive management of appropriate areas of foreshore land.	98	Implement the Coastal Lands Protection Scheme	All estuaries	WCC	H
Educate the community on the importance of maintaining, protecting and enhancing public recreational open space.	99	Prepare handouts for distribution at caravan parks and other tourist accommodation on the need for foreshore users to dispose of bait bags, drink bottles and other litter appropriately	All estuaries	WCC, SRCMA	H
Educate the community on the importance of maintaining, protecting and enhancing public recreational open space.	19	Erect signage at waterway access points on the need to protect the waterway from litter.	All estuaries	WCC	H
Manage pedestrian and vehicular access to sensitive riparian and aquatic habitats	10	Restrict or control access to sensitive estuarine habitats whilst providing appropriate access points for authorised users.	StaC, BG, BL, HC	WCC	M

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Manage pedestrian and vehicular access to sensitive riparian and aquatic habitats	17	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	BL	WCC	M
Implement a program of estuary water quality monitoring to provide Council with data on which to base management decisions.	64	Adopt and adapt the Beach Watch recreational water quality monitoring program (based on NHMRC 1990 and ANZECC 2000 criteria), and regularly monitor estuary water quality against these parameters. Publish the results on signage near the estuaries and on Council's website.	All except TTL	WCC	H
Implement a program of estuary water quality monitoring to provide Council with data on which to base management decisions.	65	Monitor estuarine water and sediment quality and ecosystem health, and catchment water and sediment quality, in accordance with the Monitoring Plan in Chapter 8 of the EMP.	All estuaries	WCC	H
Implement a program of estuary water quality monitoring to provide Council with data on which to base management decisions.	66	Erect signage near the estuary entrance to inform the community about potential water quality problems and associated health risks from primary and secondary recreational contact, particularly after rainfall.	All except TTL	WCC	H

Notes: <sup>1</sup> HC - Hargraves Creek, StaC - Stanwell Creek, StoC - Stoney Creek, FC - Flanagans Creek, SC - Slacky Creek, WC - Whartons Creek, CC - Collins Creek, BG - Bellambi Gully, BL - Bellambi Lagoon, TTL - Tom Thumb Lagoon

<sup>2</sup> H – High Priority (Rank 1-100), M – Medium Priority (Rank 101-200), L – Low Priority (Rank 201+)

**Table 6.7 Draft Management Strategies and Actions – Flooding**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Develop and implement appropriate flood management studies, plans and actions that balance flood and environmental risks and impacts.	100	Develop Floodplain Management Plans that take into consideration the effect of proposed management actions on environmental, social and cultural values.	All estuaries	WCC	H In progress
Develop and implement appropriate flood management studies, plans and actions that balance flood and environmental risks and impacts.	101	Implement relevant actions from Floodplain Management Plans, taking into consideration their likely impact on environmental, social and cultural values.	All estuaries	WCC	L
Develop and implement appropriate flood management studies, plans and actions that balance flood and environmental risks and impacts.	102	Prepare entrance management policies consistent with Floodplain Management Plans and ensure entrance management accommodates ecological requirements where possible.	All estuaries	WCC	H
Develop and implement appropriate flood management studies, plans and actions that balance flood and environmental risks and impacts.	103	Require water quality, as well as quantity, to be considered in the design of any flood detention structures.	All estuaries	WCC	M
Develop and implement appropriate flood management studies, plans and actions that balance flood and environmental risks and impacts.	104	Install rainfall, stream flow gauges and water level recorders where required.	All estuaries	WCC	L
Develop and implement appropriate flood management studies, plans and actions that balance flood and environmental risks and impacts.	105	Carry out entrance management as outlined in adopted entrance management policies	All estuaries	WCC	M
Implement a flooding awareness program for residents living within flood-prone areas	106	Prepare flood awareness brochures for distribution to residents in flood-prone areas.	All estuaries	WCC	L

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<sup>2</sup> H – High Priority (Rank 1-100), M – Medium Priority (Rank 101-200), L – Low Priority (Rank 201+)

**Table 6.8 Draft Management Strategies and Actions – Visual Amenity**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Maintain and enhance visual amenity by the adoption and implementation of appropriate planning controls.	107	Prepare and adopt a Visual Management System for the LGA setting out the methodology for undertaking visual assessments	All estuaries	WCC	L
Maintain and enhance visual amenity by the adoption and implementation of appropriate planning controls.	108	Prepare a Visual Management Plan (VMP) to maintain significant views and vistas and require, through planning instruments, development control plans and design guidelines that all building and development applications conform to the VMP.	All except TTL	WCC	M
Maintain and enhance visual amenity by the adoption and implementation of appropriate planning controls.	109	Require, through an LGA-wide DCP, that foreshore protection to control erosion conforms to the VMP and be of a standardised type utilising local native plants with harder materials, such as timber or rock, only where necessary.	All estuaries	WCC	M
Encourage community involvement in the maintenance, enhancement and enjoyment of the existing visual amenity	110	Provide foreshore viewing platforms if required.	All estuaries	WCC	L
Encourage community involvement in the maintenance, enhancement and enjoyment of the existing visual amenity	111	Provide local native trees, shrubs and other plants for use on waterfront properties.	All estuaries	WCC	M
Encourage community involvement in the maintenance, enhancement and enjoyment of the existing visual amenity	15	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives.	FC, SL, WC, CC, BG	WCC	H
Encourage community involvement in the maintenance, enhancement and enjoyment of the existing visual amenity	112	Educate the community and, in particular, the landholders adjacent to the waterway or in the first row of houses behind foreshore roadways, on the value of not clearing their land or waterfront reserves to improve their own views, and the penalties for illegal clearing. Regenerate illegally cleared areas and erect highly visible fencing (eg. orange safety fencing) and signage as deterrents.	All estuaries	WCC, SRCMA	M

Notes: <sup>1</sup> HC - Hargraves Creek, StaC - Stanwell Creek, StoC - Stoney Creek, FC - Flanagans Creek, SC - Slacky Creek, WC - Whartons Creek, CC - Collins Creek, BG - Bellambi Gully, BL - Bellambi Lagoon, TTL - Tom Thumb Lagoon  
<sup>2</sup> H – High Priority (Rank 1-100), M – Medium Priority (Rank 101-200), L – Low Priority (Rank 201+)

**Table 6.9 Draft Management Strategies and Actions – Entrance Management**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Develop entrance management policies considering location of past openings, flood mitigation (as per FMPs), water quality, fish and invertebrate recruitment, birdlife, threatened species, cultural sites, ecology and local resident's wishes.	113	Prepare entrance management policy in consultation with the community, the Estuary Management Committee, and Councillors.	BL	WCC	L
Develop entrance management policies considering location of past openings, flood mitigation (as per FMPs), water quality, fish and invertebrate recruitment, birdlife, threatened species, cultural sites, ecology and local resident's wishes.	114	Where appropriate, implement entrance management policy, using the media to publicise entrance opening events.	BL	WCC	L
Develop entrance management policies considering location of past openings, flood mitigation (as per FMPs), water quality, fish and invertebrate recruitment, birdlife, threatened species, cultural sites, ecology and local resident's wishes.	115	Establish a monitoring program to record date of opening and closing, nature of opening (natural or manual), location and width across the entrance dune, ocean water level, width and depth of channel development with time, estuary water levels through time and water velocities.	All estuaries, except TTL	WCC	H
Educate the community on the importance of not illegally opening an estuary entrance and the consequent liability to prosecution if caught.	116	Publicise the dangers and risks of illegally opening estuary entrances through the media, and include warnings on signage adjacent to estuary entrances or at beach reserve carparks.	All estuaries	WCC	H

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<sup>2</sup> H – High Priority (Rank 1-100), M – Medium Priority (Rank 101-200), L – Low Priority (Rank 201+)

**Table 6.10 Draft Management Strategies and Actions – Information and Communications**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Raise community awareness of the importance of estuaries and measures they can take to protect and enhance them.	117	Distribute an Estuary Management Plan summary to local residents and make the full plan available for public perusal at any time. Consult the local community and other stakeholders prior to implementing management actions.	All estuaries	WCC	H
Raise community awareness of the importance of estuaries and measures they can take to protect and enhance them.	118	Maintain an action plan to log the progress and success of the implementation of estuary management plan actions. Update the plan after each Estuary Management Committee meeting and distribute to interested parties, including the media, on request.	All estuaries	WCC	H
Raise community awareness of the importance of estuaries and measures they can take to protect and enhance them.	119	Develop an education brochure outlining the impacts of human activity on estuary condition and the actions that can be taken at a personal level to maintain estuary health. Distribute with rates notices and make available at appropriate distribution opportunities.	All estuaries	WCC, SRCMA	H
Raise community awareness of the importance of estuaries and measures they can take to protect and enhance them.	120	Develop a plan, preferably using a Geographical Information System, to be used in conjunction with the action plan, showing land and waterway uses and current planning and development activities occurring in the estuary and the catchment.	All estuaries	WCC	H
Raise community awareness of the importance of estuaries and measures they can take to protect and enhance them.	121	Use the local media to publicise Estuary Management Plans, the results of monitoring programs, and issues of concern as they arise.	All estuaries	WCC	H
Raise community awareness of the importance of estuaries and measures they can take to protect and enhance them.	122	Use Council's web site as a means of distributing all the above educational material.	All estuaries	WCC	H
Raise community awareness of the importance of estuaries and measures they can take to protect and enhance them.	123	Identify, maintain, support, improve and acknowledge the existing partnerships with Friends of TTL, CVA, PKPC, Port Kembla Coal Terminal, BlueScope Steel, CMA, DECC, DPI, SWC and other Divisions of WCC, and the success of their combined efforts in improving the management of TTL	TTL	TTL stakeholders	H
Raise community awareness of the importance of estuaries and measures they can take to protect and enhance them.	124	Maintain and improve the existing partnership approach to facilitate the improved management, clean-up and notification of sewage overflow events affecting TTL, including consideration of installing a gross pollutant trap, and maintenance of SWC infrastructure throughout TTL.	TTL	CVA, FoTTL, SWC	H



Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Raise community awareness of the importance of estuaries and measures they can take to protect and enhance them.	125	Investigate the undertakings agreed between SWC and WCC in the 1980's relating to the ongoing management of Bellambi Lagoon, and implement as appropriate.	BL	WCC, SWC	H

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**Table 6.11 Draft Management Strategies and Actions – Monitoring**

Management Strategy	Management Action No	Management Action	Estuary <sup>1</sup>	Responsibility & Involvement	Priority <sup>2</sup>
Develop and implement a monitoring program for each strategy in the Management Plan to assess performance and enable plan auditing at regular intervals and subsequent adaptation of the plan.	126	Implement the Monitoring Plan detailed in Chapter 8 of the EMP (or alternative).	All estuaries	WCC	M
Establish community monitoring projects	127	Develop appropriate community monitoring projects.	All estuaries	WCC, SRCMA	M

Notes: <sup>1</sup> HC - Hargraves Creek, StaC - Stanwell Creek, StoC - Stoney Creek, FC - Flanagans Creek, SC - Slacky Creek, WC - Whartons Creek, CC - Collins Creek, BG - Bellambi Gully, BL - Bellambi Lagoon, TTL - Tom Thumb Lagoon

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### 6.3 Assessment of strategies

The management actions detailed in Tables 6.1-6.11 were assessed using a cost benefit analysis and triple bottom line assessment in order to rank the strategies and actions in terms of effectiveness, cost and expected benefits. The cost benefit analysis was based on the likely capital and recurrent expenditure required to implement the strategies and actions, based on professional judgement. The triple bottom line assessment considered the perceived adverse and beneficial impacts of each management strategy/action on the estuarine values of flora, fauna, water/sediment quality, flooding, human users and cultural heritage. The scores were assigned by the project team based on the descriptors detailed in Table 6.12. The draft scores were subsequently refined through discussion with Councillors, Council staff, DECC and the EMC.

A weighting of 10% was given to the scores for flora and fauna, and water/sediment quality, to reflect the principle of Ecologically Sustainable Development (ESD) that *the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making*. The weighting also reflects comments received from the EMC relating to the relative merits of each score, and in particular the fact that the original rankings resulted in important water quality improvement actions being given a low priority.

In addition, a weighting of 25% was given to the scores for cultural heritage to reflect community comments relating to the importance of conserving both Aboriginal and European cultural heritage values. The weighting was considered necessary as cultural heritage management actions generally do not affect other criteria such as water quality, flora/fauna, etc, and so cultural heritage actions are inherently disadvantaged by the scoring system.

The weighting of the scores is anticipated to accord with general community expectations and values relating to the conservation of estuarine habitats and cultural values.

**Table 6.12 Triple Bottom Line Assessment Descriptors**

Score	Descriptor
+ / - 5	Long term, direct and large positive or negative impact
+ / - 4	Long term, indirect, large positive or negative impact; or Long term, direct, medium positive or negative impact
+ / - 3	Medium term, direct and/or indirect, moderate positive or negative impact
+ / - 2	Short term, indirect, large positive or negative impact; or Short term, direct, medium positive or negative impact.
+ / - 1	Indirect, small positive or negative impact
0	No, or neutral, impact



The assessment was used to rank the management strategies and actions according to the perceived value, based on their Net Present Value and the benefits expected to accrue from their implementation. The NPV was calculated assuming a 7% discount rate over 50 years.

The results of the assessment form the Estuary Management Plan, and are documented in Section 7.

## 7. Estuary Management Plan

The estuary management actions identified in this report are presented in Table 7.1 (in Appendix A), ranked according to the results of the cost-benefit analysis.

The estuary management actions are also re-presented in Table 7.2 (in Appendix B), ordered by estuary then rank, to highlight estuary-specific actions.

Consultation would be undertaken with the Aboriginal community prior to any works that might affect any areas of potential Aboriginal heritage significance.



## 8. Monitoring Plan

Monitoring the effectiveness of the implementation of the management objectives, strategies and actions detailed in this EMSP is critical in order to provide quantifiable measures of progress against baseline conditions. Monitoring provides information that is useful in assessing whether scarce resources are being most effectively targeted to obtain the best outcomes.

The monitoring plan detailed in Table 8.1 details indicators that should be monitored, recommended frequency of the monitoring, and performance criteria against which the results should be assessed.

The results of the monitoring should be reviewed periodically to assess the performance of the management actions in achieving the desired outcomes. The review process will assist in identifying whether management actions are being successful, and should be continued, or whether they are not successful, and should be amended or substituted.

**Table 8.1 Monitoring Plan**

Management Objective	Indicator	Monitoring Requirement
Habitat and Species Conservation	Weed invasion of EECs	6-monthly monitoring and assessment of weed species and their invasion of EECs. <i>Performance:</i> Annual decline in weed species and extent against baseline.
Habitat and Species Conservation	Extent/distribution of EECs and key habitats	Annual analysis of photographic or satellite imagery To identify any changes in extent or distribution of EECs and other key habitat and vegetation types <i>Performance:</i> Change in condition from baseline data
Water Quality Recreation	Faecal coliforms	Faecal coliforms monitored at least monthly at all estuaries used for primary and secondary contact recreational activities. Additional monitoring to be undertaken following sewer overflow events and rainfall events. <i>Performance:</i> Conformance with Beachwatch (NHMRC/ANZECC) criteria.
Water Quality Recreation	Heavy Metals	Quarterly monitoring of heavy metals in the water column for the first year at all sites, annually thereafter if concentrations demonstrated to be stable. Analyse for Cu, Zn, Pb, Mn, As and Fe. Heavy metals in the sediment to be monitored on one occasion in the first year then every 5 years thereafter at Tom Thumb Lagoon (2 locations), Bellambi Lagoon (2 locations) and Bellambi Gully (1 location). <i>Performance:</i> Number of exceedences of localised guideline per year

Management Objective	Indicator	Monitoring Requirement
Water Quality	Temperature, pH, turbidity, dissolved oxygen saturation, salinity, TN, TKN, NOx, NH4+, TP and TRP, chlorophyll-a	Monitored monthly at all estuaries and following significant rainfall events (>25 mm). <i>Performance:</i> Number of exceedences of localised guideline per year
Water Quality Recreation Visual Amenity	Algal blooms	Monthly algal monitoring during summer months at popular recreational estuaries in the event that blooms occur. <i>Performance:</i> Number of exceedences of 15,000 cells/mL annually.
Water Quality Recreation Visual Amenity	Gross pollutant removal	Weight/volume of gross pollutants removed from traps and on Clean-up Australia Day. <i>Performance:</i> Change in gross pollutant load over time.
Water Quality Recreation Visual Amenity	Sewer overflows	Monitor Sydney Water records of dry and wet weather sewer overflows for comparison with water quality data. <i>Performance:</i> Number of overflows per year.
Sedimentation and Erosion	Bank erosion	Monitor extent of bank erosion in all catchment <i>Performance:</i> Reduction in extent and severity of erosion against baseline conditions
Estuary Entrance	Entrance behaviour	Monitoring and recording of all entrance openings and closings, including times, duration, water levels, berm heights, and associated rainfall conditions etc. <i>Performance:</i> For information only.
Estuarine Aquatic Ecosystem Health	As per forthcoming SRCMA Framework	As per forthcoming SRCMA Framework.

## 9. References

GHD (2007a) Estuary Processes Study for Several Wollongong Creeks and Lagoons. A report prepared for Wollongong City Council.

GHD (2007b) Estuary Management Study and Plan for Several Wollongong Creeks and Lagoons, Submissions in Reply Report. A report prepared for Wollongong City Council.

NSW Government (1992) *Estuary Management Manual*, New South Wales Government, October 1992

WBM Oceanics (2006) Wollongong Northern Coastal Creeks and Lagoons: Data Compilation and Review Report.





Appendix A  
Estuary Management Plan  
Management Actions Ordered by Rank

Table 7.1 Management Actions ordered by Rank

Management Action No	Management Action	Estuary	Responsibility & Involvement	Capital Cost	Recurrent Cost	NPV	Flora Impact - Aquatic and Terrestrial	Fauna Impact - Aquatic, Terrestrial, Avifauna	Water & Sediment Quality Impact	Flooding Impact	Human User Impact	Cultural Heritage Impact	Benefit Index	Benefit Index / Log NPV	Rank	Notes
1	Ensure estuaries are appropriately zoned (prohibiting certain development types), dedicated and/or reserved, and appropriate development controls are implemented.	All estuaries	WCC	\$1,000	\$0	\$1,000	4	4	4	0	3	3	19.95	\$6.65	1	In progress
5	Adopt riparian objectives and control measures as detailed in Council's Riparian Development Control Plan.	All estuaries	WCC, SRCMA	\$2,000	\$0	\$2,000	3	3	3	3	3	3	19.65	\$5.95	2	-
3	Review public ownership of foreshore and riparian areas whenever opportunities arise through rezoning, development approvals or acquisition (including like-for-like contributions from developers/landowners)	All estuaries	WCC	\$1,000	\$1,000	\$14,801	4	4	4	2	4	3	22.95	\$5.50	3	In progress
19q	Provide signage to educate the community about the damage caused to dunes and Aboriginal heritage area through inappropriate activities and access, including the illegal removal of beach sand.	All estuaries, particularly Bellambi Lagoon	WCC, SRCMA	\$2,000	\$500	\$8,900	3	3	4	2	1	5	20.25	\$5.13	4	-
10a	Restrict or control access to sensitive estuarine habitats whilst providing appropriate access points for authorised users.	All estuaries except Tom Thumb Lagoon	WCC, CVA, SRCMA	\$10,000	\$1,000	\$23,801	5	4	3	0	3	3	19.95	\$4.56	5	-
4	Introduce appropriate zoning or an LEP clause requiring consent from Council for any development within reserves and buffer zones, except for fencing, revegetation or any works contained in an Estuary Management Plan and prohibiting certain development types altogether.	All estuaries	WCC	\$1,000	\$0	\$1,000	2	2	2	2	2	2	13.1	\$4.37	6	In progress
87	Undertake stabilisation works on the northern bank of Bellambi Lagoon entrance to prevent/minimise further erosion and encroachment into an area of Aboriginal heritage.	Bellambi Lagoon	WCC, DECC, SRCMA	\$20,000	\$5,000	\$89,004	3	3	3	0	5	5	21.15	\$4.27	7	-
52	Prepare Stormwater Management Plans for existing developed areas within the framework of the cumulative impact assessment.	All estuaries	WCC	\$10,000	\$2,000	\$37,601	4	4	4	2	4	0	19.2	\$4.20	8	-
123	Identify, maintain, support, improve and acknowledge the existing partnerships with Friends of TTL, CVA, PKPC, Port Kembla Coal Terminal, Bluescope Steel, CMA, DECC, DPI, SWC and other Divisions of WCC, and the success of their combined efforts in improving the management of TTL.	TTL	TTL Stakeholders	\$500	\$500	\$7,400	3	3	3	3	3	0	15.9	\$4.11	9	-
124	Maintain and improve the existing partnership approach to facilitate the improved management, clean-up and notification of sewage overflow events affecting TTL, including consideration of installing a gross pollutant trap, and maintenance of SWC infrastructure throughout TTL.	TTL	CVA, FoTLL, SWC	\$500	\$500	\$7,400	3	3	3	3	3	0	15.9	\$4.11	9	-
34d	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	5	3	2	0	4	2	17.5	\$4.00	11	In progress
88	Replace existing temporary fencing with permanent fencing to discourage human disturbance of particularly sensitive areas of the dunes and heritage area.	Bellambi Lagoon	WCC, DECC, SRCMA	\$15,000	\$5,000	\$84,004	3	2	2	0	5	5	18.95	\$3.85	12	-
119	Develop an education brochure outlining the impacts of human activity on estuary condition and the actions that can be taken at a personal level to maintain estuary health. Distribute with rates notices and make available at frequent visitation points.	All estuaries	WCC, SRCMA	\$7,500	\$1,000	\$21,301	2	2	4	2	3	2	16.3	\$3.77	13	-
66	Erect signage near the estuary entrance to inform the community about potential water quality problems and associated health risks from primary and secondary recreational contact, particularly after rainfall.	All estuaries except Tom Thumb Lagoon	WCC	\$2,500	\$500	\$9,400	2	2	5	0	5	0	14.9	\$3.75	14	-
14a	Establish and maintain well-vegetated riparian zones using appropriate local native riparian vegetation in accordance with floodplain management objectives and Sydney Water infrastructure.	Stoney Creek	WCC, SRCMA	\$10,000	\$1,000	\$23,801	4	4	4	0	3	0	16.2	\$3.70	15	-
38	Protect the Bangalay Sand Forest habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	Bellambi Lagoon	WCC, DECC, SRCMA	\$0	\$2,000	\$27,601	4	4	3	2	2	0	16.1	\$3.63	16	-
35a	Protect the swamp oak floodplain habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	Stanwell Creek	WCC, DECC	\$0	\$2,000	\$27,601	4	4	3	2	2	0	16.1	\$3.63	16	-
35b	Protect the swamp oak floodplain habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	Bellambi Lagoon	WCC, DECC	\$0	\$2,000	\$27,601	4	4	3	2	2	0	16.1	\$3.63	16	-
35c	Protect the swamp oak floodplain habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	Tom Thumb Lagoon	WCC, DECC	\$0	\$2,000	\$27,601	4	4	3	2	2	0	16.1	\$3.63	16	-
45	Develop and adopt water quality standards (as per ANZECC 2000) for the estuary to identify appropriate standards for aquatic ecosystem health.	All estuaries	WCC	\$15,000	\$1,000	\$28,801	3	3	5	0	4	0	16.1	\$3.61	20	In progress
125	Investigate the undertakings agreed between SWC and WCC in the 1980's relating to the ongoing management of Bellambi Lagoon, and implement as appropriate.	Bellambi Lagoon	WCC	\$5,000	\$5,000	\$74,004	3	3	3	3	2	2	17.4	\$3.57	21	-
50	Adopt water-sensitive urban design principles, using the LEP or a separate LGA wide DCP.	All estuaries	WCC	\$10,000	\$2,000	\$37,601	3	2	5	3	2	0	16	\$3.50	22	In progress
92	Require that a Local Environmental Study be prepared for a major LEP or rezoning proposal for any area within or adjoining an estuary. The LES should consider potential impacts on estuarine values including the ecosystem, threatened species, water quality, cultural heritage, foreshore and estuary access and usage, population levels with tourist influx, public amenity, fishing and acid sulphate soils.	All estuaries	Proponent	\$100,000	\$0	\$100,000	3	3	3	3	2	2	17.4	\$3.48	23	-
11	Remove non-native and noxious species and revegetate and regenerate using local native species.	All estuaries	WCC, CVA, SRCMA	\$10,000	\$1,000	\$23,801	5	3	2	0	4	0	15	\$3.43	24	-
34a	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	5	3	2	0	4	0	15	\$3.43	24	In progress
34b	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Collins Creek	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	5	3	2	0	4	0	15	\$3.43	24	In progress

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34c	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	5	3	2	0	4	0	15	\$3.43	24	In progress
34e	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	5	3	2	0	4	0	15	\$3.43	24	In progress
34f	Implement weed control programs to prevent and control infestation of Swamp Oak Floodplain EEC.	Stanwell Creek	WCC, CVA, DECC, SRCMA	\$10,000	\$1,000	\$23,801	5	3	2	0	4	0	15	\$3.43	24	In progress
34g	Implement weed control programs to prevent and control infestation of Swamp Oak Floodplain EEC.	Bellambi Lagoon	WCC, CVA, DECC, SRCMA	\$10,000	\$1,000	\$23,801	5	3	2	0	4	0	15	\$3.43	24	In progress
34h	Implement weed control programs to prevent and control infestation of Swamp Oak Floodplain EEC.	Tom Thumb Lagoon	WCC, CVA, DECC, SRCMA	\$10,000	\$1,000	\$23,801	5	3	2	0	4	0	15	\$3.43	24	In progress
19k	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC	Bellambi Lagoon	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	3	3	13.35	\$3.38	32	-
89	Erect interpretative signage at the beach reserve and adjacent to the Aboriginal heritage area.	Bellambi Lagoon	WCC, DECC	\$5,000	\$1,500	\$25,701	2	1	0	0	5	5	14.55	\$3.30	33	-
70d	Stabilise dunes near the estuary entrance in accordance with best management practice.	Bellambi Lagoon	WCC	\$50,000	\$10,000	\$188,007	4	2	2	0	2	5	17.05	\$3.23	34	-
14b	Establish and maintain well-vegetated riparian zones using appropriate local native riparian vegetation in accordance with floodplain management objectives and Sydney Water infrastructure.	Flanagans Creek	WCC, SRCMA	\$20,000	\$2,000	\$47,601	3	4	4	0	3	0	15.1	\$3.23	35	-
64	Adopt and adapt the Beach Watch recreational water quality monitoring program (based on NHMRC 1990 and ANZECC 2000 criteria), and regularly monitor estuary water quality against these parameters. Publish the results on signage near the estuaries and on Council's website.	All estuaries except Tom Thumb Lagoon	WCC	\$1,000	\$15,000	\$208,011	3	3	5	0	5	0	17.1	\$3.22	36	-
65	Monitor estuarine water and sediment quality and ecosystem health, and catchment water and sediment quality, in accordance with the Monitoring Plan in Chapter 8 of the EMP.	All estuaries	WCC	\$2,500	\$15,000	\$209,511	3	3	5	0	5	0	17.1	\$3.21	37	-
14c	Establish and maintain well-vegetated riparian zones using appropriate local native riparian vegetation in accordance with floodplain management objectives and Sydney Water infrastructure.	Whartons Creek	WCC, SRCMA	\$25,000	\$2,500	\$59,502	3	4	4	0	3	0	15.1	\$3.16	38	-
19a	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc	Bellambi Lagoon	WCC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	2	3	12.35	\$3.13	39	-
18	Relocate or control access to existing informal paths to minimize impacts on the sensitive vegetation or habitats.	Bellambi Lagoon	WCC, SRCMA	\$20,000	\$5,000	\$89,004	5	4	2	0	-3	5	15.35	\$3.10	40	-
10k	Relocate or control access to existing informal paths to minimize impacts on the sensitive vegetation or habitats.	Bellambi Lagoon	WCC, SRCMA	\$20,000	\$5,000	\$89,004	5	4	2	0	-3	5	15.35	\$3.10	40	-
61a	Require all residents to connect to the Stanwell Park Sewerage Scheme.	Hargraves Creek	WCC	\$0	\$5,000	\$69,004	2	2	5	0	5	0	14.9	\$3.08	42	-
61b	Require all residents to connect to the Stanwell Park Sewerage Scheme.	Stanwell Creek	WCC	\$0	\$5,000	\$69,004	2	2	5	0	5	0	14.9	\$3.08	42	-
61c	Require all residents to connect to the Stanwell Park Sewerage Scheme.	Stoney Creek	WCC	\$0	\$5,000	\$69,004	2	2	5	0	5	0	14.9	\$3.08	42	-
9a	Investigate and protect areas of valuable fish nursery habitat (seagrasses and mangroves), including an assessment of the implications of water quality and macroalgae on seagrasses.	Bellambi Lagoon	WCC, CVA, DPI	\$10,000	\$1,000	\$23,801	4	5	3	0	0	0	13.2	\$3.02	45	-
9b	Investigate and protect areas of valuable fish nursery habitat (seagrasses and mangroves), including an assessment of the implications of water quality and macroalgae on seagrasses.	Tom Thumb Lagoon	WCC, CVA, DPI	\$10,000	\$1,000	\$23,801	4	5	3	0	0	0	13.2	\$3.02	45	-
43	Erect signage adjacent to sensitive habitats to inform Council staff not to mow/slash the vegetation	All estuaries except Tom Thumb Lagoon	WCC	\$2,000	\$500	\$8,900	4	3	2	0	2	0	11.9	\$3.01	47	-
48	Incorporate in the Soil and Water Management Policy a condition that pre- and post-development monitoring be undertaken to prove compliance with the standards at the developer's cost.	All estuaries	WCC	\$2,000	\$0	\$2,000	3	2	4	0	0	0	9.9	\$3.00	48	-
98	Implement the Coastal Lands Protection Scheme	All estuaries	WCC	\$0	\$2,000	\$27,601	2	2	2	2	2	2	13.1	\$2.95	49	-
117	Distribute an Estuary Management Plan summary to local residents and make the full plan available for public perusal at any time. Consult the local community and other stakeholders prior to implementing management actions.	All estuaries	WCC	\$5,000	\$2,000	\$32,601	2	2	2	2	2	2	13.1	\$2.90	50	-
121	Use the local media to publicise Estuary Management Plans, the results of monitoring programs, and issues of concern as they arise.	All estuaries	WCC	\$5,000	\$2,000	\$32,601	2	2	2	2	2	2	13.1	\$2.90	50	-
24a	Further investigate the importance of the potential habitat to the threatened species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	Hargraves Creek	WCC, DECC	\$5,000	\$0	\$5,000	4	3	0	0	3	0	10.7	\$2.89	52	-
24b	Further investigate the importance of the potential habitat to the threatened species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	Stanwell Creek	WCC, DECC	\$5,000	\$0	\$5,000	4	3	0	0	3	0	10.7	\$2.89	52	-
24c	Further investigate the importance of the potential habitat to the threatened species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	Bellambi Gully	WCC, DECC	\$5,000	\$0	\$5,000	4	3	0	0	3	0	10.7	\$2.89	52	-
24d	Further investigate the importance of the potential habitat to the threatened species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	Bellambi Lagoon	WCC, DECC	\$5,000	\$0	\$5,000	4	3	0	0	3	0	10.7	\$2.89	52	-
118	Maintain an action plan to log the progress and success of the implementation of estuary management plan actions. Update the plan after each Estuary Management Committee meeting and distribute to interested parties, including the media, on request.	All estuaries	WCC	\$1,000	\$2,500	\$35,502	2	2	2	2	2	2	13.1	\$2.88	56	-
59a	Include acid sulphate soil provisions in LEP. Identify any existing acid sulphate drainage, remediate and, if required, prepare a plan for ongoing management.	All estuaries	WCC	\$5,000	\$5,000	\$74,004	3	3	4	0	3	0	14	\$2.88	57	In progress

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7a	Investigate the potential impacts on estuarine ecology and water quality of the proposed removal of the causeway across Garangaty waterway, and modify/remove this potential barrier to fish passage as appropriate.	Tom Thumb Lagoon	WCC, CVA, DPI	\$100,000	\$0	\$100,000	5	4	4	0	0	0	14.3	\$2.86	58	-
29e	Investigate and manage water quality and hydrological impacts on saltmarsh	Tom Thumb Lagoon	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	3	3	3	0	0	0	9.9	\$2.85	59	In progress
100	Develop Floodplain Management Plans that take into consideration the effect of proposed management actions on environmental, social and cultural values.	All estuaries	WCC	\$150,000	\$25,000	\$495,019	2	2	2	5	2	2	16.1	\$2.83	60	In progress
42	Erect appropriate barriers around foreshore vegetation to prevent mowing by Council outdoor staff.	All estuaries except Tom Thumb Lagoon	WCC	\$10,000	\$500	\$16,900	4	3	2	0	2	0	11.9	\$2.81	61	-
15a	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Flanagans Creek	WCC, SRCMA	\$200,000	\$0	\$200,000	3	3	3	2	3	0	14.9	\$2.81	62	-
15b	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Slacky Creek	WCC, SRCMA	\$200,000	\$0	\$200,000	3	3	3	2	3	0	14.9	\$2.81	62	-
15c	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Whartons Creek	WCC, SRCMA	\$200,000	\$0	\$200,000	3	3	3	2	3	0	14.9	\$2.81	62	-
15d	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Collins Creek	WCC, SRCMA	\$200,000	\$0	\$200,000	3	3	3	2	3	0	14.9	\$2.81	62	-
15e	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Bellambi Gully	WCC, SRCMA	\$200,000	\$0	\$200,000	3	3	3	2	3	0	14.9	\$2.81	62	-
116	Publicise the dangers and risks of illegally opening estuary entrances through the media, and include warnings on signage adjacent to estuary entrances or at beach reserve carparks.	All estuaries	WCC	\$2,000	\$500	\$8,900	2	2	2	0	2	2	11.1	\$2.81	67	-
7b	Investigate the potential impacts on estuarine ecology and water quality of the small weir across Slacky Creek (located immediately upstream of the road), and modify/remove this potential barrier to fish passage as appropriate.	Slacky Creek	WCC, CVA, DPI	\$50,000	\$0	\$50,000	4	4	4	0	0	0	13.2	\$2.81	68	-
25a	Retain large stands of native and riparian vegetation, identify and protect any hollow-bearing trees and retain younger recruitment trees to replace older trees in the long-term, through implementation of DCPs and DA approval process.	Hargraves Creek	WCC, DECC	\$4,000	\$3,000	\$45,402	4	3	2	0	3	0	12.9	\$2.77	69	In progress
25b	Retain large stands of native and riparian vegetation, identify and protect any hollow-bearing trees and retain younger recruitment trees to replace older trees in the long-term, through implementation of DCPs and DA approval process.	Stanwell Creek	WCC, DECC	\$4,000	\$3,000	\$45,402	4	3	2	0	3	0	12.9	\$2.77	69	In progress
25c	Retain large stands of native and riparian vegetation, identify and protect any hollow-bearing trees and retain younger recruitment trees to replace older trees in the long-term, through implementation of DCPs and DA approval process.	Bellambi Gully	WCC, DECC	\$4,000	\$3,000	\$45,402	4	3	2	0	3	0	12.9	\$2.77	69	In progress
25d	Retain large stands of native and riparian vegetation, identify and protect any hollow-bearing trees and retain younger recruitment trees to replace older trees in the long-term, through implementation of DCPs and DA approval process.	Bellambi Lagoon	WCC, DECC	\$4,000	\$3,000	\$45,402	4	3	2	0	3	0	12.9	\$2.77	69	In progress
86	Protect sites through the LEP following review of the heritage schedule	Bellambi Lagoon	WCC, DECC	\$5,000	\$500	\$11,900	0	0	0	0	5	5	11.25	\$2.76	73	In progress
99	Prepare handouts for distribution at caravan parks and other tourist accommodation on the need for foreshore users to dispose of bait bags, drink bottles and other litter appropriately	All estuaries	WCC, SRCMA	\$5,000	\$1,000	\$18,801	2	1	4	0	4	0	11.7	\$2.74	74	-
122	Use Council's web site as a means of distributing all the above educational material.	All estuaries	WCC	\$1,000	\$5,000	\$70,004	2	2	2	2	2	2	13.1	\$2.70	75	-
120	Develop a plan, preferably using a Geographical Information System, to be used in conjunction with the action plan, showing land and waterway uses and current planning and development activities occurring in the estuary and the catchment.	All estuaries	WCC	\$2,000	\$5,000	\$71,004	2	2	2	2	2	2	13.1	\$2.70	76	-
44	Establish Standard Operating Procedures for Council staff to follow to prevent mowing/slashing of sensitive vegetation (including EECs), inappropriate use of herbicides/pesticides, etc, incorporating maps or photos of the sensitive habitats. Investigate Council's control over inappropriate aerial herbicide spraying undertaken by the Illawarra District Noxious Weed Authority (IDNWA).	All estuaries	WCC, IDNWA	\$2,500	\$500	\$9,400	3	3	1	0	3	0	10.7	\$2.69	77	-
6	Negotiate property vegetation plans agreements and property management plans with owners of land with vegetation communities plant and animal species and/or ecological communities or populations of significant conservation value.	All estuaries	WCC, SRCMA	\$5,000	\$5,000	\$74,004	5	5	1	0	1	0	13.1	\$2.69	78	-
46	Calculate pollutant inventories and budgets for existing land uses and prepare land and water capability assessments to establish total allowable pollutant loads and other relevant loads or factors.	All estuaries	WCC	\$40,000	\$10,000	\$178,007	3	3	5	0	2	0	14.1	\$2.69	79	-
27a	Protect and manage potential habitat by creating buffer zones around it (with vegetation or through maintenance of high water levels) to minimise risk of human disturbance.	Bellambi Gully	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	4	3	2	0	2	0	11.9	\$2.67	80	-
27b	Protect and manage potential habitat by creating buffer zones around it (with vegetation or through maintenance of high water levels) to minimise risk of human disturbance.	Bellambi Lagoon	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	4	3	2	0	2	0	11.9	\$2.67	80	-

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62	Educate the community on environmentally responsible practices around the house that protect water quality by developing a brochure for distribution to all residents, recommending measures including: composting grass clippings; using organic rather than synthetic fertilisers; applying fertiliser sparingly and according to soil requirements; vegetating bare soil areas; using phosphate-free detergents; washing cars on grass; capturing pet droppings; and not dumping domestic refuse, including grass clippings, on the foreshores and riverbanks or in the bush.	All estuaries	WCC, SRCMA	\$5,000	\$2,000	\$32,601	3	3	4	0	1	0	12	\$2.66	82	In progress
55	Regularly inspect and maintain stormwater treatment devices to ensure continued effectiveness.	All estuaries, particularly Tom Thumb Lagoon	WCC	\$0	\$5,000	\$69,004	2	2	4	2	2	0	12.8	\$2.65	83	In progress
90	Investigate sites and areas of potential cultural heritage significance (Aboriginal and European, including the campsites near Stanwell Creek) and protect as necessary.	All estuaries	WCC, DECC	\$5,000	\$1,000	\$18,801	0	0	0	0	5	5	11.25	\$2.63	84	-
40	Initiate community awareness programs that highlight the presence of threatened species populations and catchment management approaches to improving stormwater quality, habitat retention and management.	All estuaries	WCC, DECC, SRCMA	\$5,000	\$1,000	\$18,801	2	2	2	0	2	2	11.1	\$2.60	85	-
102	Prepare entrance management policies consistent with Floodplain Management Plans and ensure entrance management accommodates ecological requirements where possible.	All estuaries	WCC	\$25,000	\$5,000	\$94,004	2	2	2	4	1	1	12.85	\$2.58	86	-
74	Investigate and if necessary de-silt Stanwell Creek immediately downstream of the causeway to restore its original profile and depth (following finalisation of repairs/reconstruction of Lower Coast Road).	Stanwell Creek	WCC	\$25,000	\$5,000	\$94,004	2	2	4	2	2	0	12.8	\$2.57	87	-
81	Provide rock toe protection at area of bank erosion S1 (refer Figures F1-F10 in the EPS report), re-shape the upper bank, and revegetate.	Slacky Creek	WCC, SRCMA	\$40,000	\$5,000	\$109,004	3	3	3	0	3	0	12.9	\$2.56	88	-
82	Provide rock toe protection at area of bank erosion S2 (refer Figures F1-F10 in the EPS report), or re-shape, to minimize erosion. Revegetate to improve riparian vegetation corridor and increase bank stability.	Slacky Creek	WCC, SRCMA	\$40,000	\$5,000	\$109,004	3	3	3	0	3	0	12.9	\$2.56	88	-
115	Establish a monitoring program to record date of opening and closing, nature of opening (natural or manual), location and width across the entrance dune, ocean water level, width and depth of channel development with time, estuary water levels through time and water velocities.	All estuaries except Tom Thumb Lagoon	WCC	\$5,000	\$10,000	\$143,007	2	2	2	2	2	2	13.1	\$2.54	90	-
56a	Investigate reported water pollution events to determine and rectify the source. Investigate and rectify source of pollution of a small ephemeral tributary of Hargraves Creek, which has large volumes of bubbles and a grey colouration during rainfall periods. Investigate the potential impact of the impoundment of Stoney Creek on water quality, hydrology and ecology.	Hargraves Creek	WCC	\$2,500	\$0	\$2,500	2	2	2	0	2	0	8.6	\$2.53	91	-
56b	Investigate reported water pollution events to determine and rectify the source. Investigate and rectify source of pollution of a small ephemeral tributary of Hargraves Creek, which has large volumes of bubbles and a grey colouration during rainfall periods. Investigate the potential impact of the impoundment of Stoney Creek on water quality, hydrology and ecology.	Stoney Creek	WCC	\$2,500	\$0	\$2,500	2	2	2	0	2	0	8.6	\$2.53	91	-
30	Investigate and manage competition between mangroves and saltmarsh in consultation with DPI	Tom Thumb Lagoon	WCC, CVA, DPI, DECC	\$1,500	\$1,500	\$22,201	4	3	3	0	0	0	11	\$2.53	93	In progress
68a	Monitor impacts associated with leachate discharges from the old landfill at TTL.	Tom Thumb Lagoon	WCC	\$25,000	\$10,000	\$163,007	3	3	4	0	2	0	13	\$2.49	94	In progress
68b	Monitor impacts associated with leachate discharges from the old landfill at Collins Creek.	Collins Creek	WCC	\$25,000	\$10,000	\$163,007	3	3	4	0	2	0	13	\$2.49	94	-
73	Investigate alternative methods to repair Lower Beach Road, Stanwell Park, to minimise erosion of material and deposition in Stanwell Creek. Alternatively, re-design and resurface the road to restore integrity and stability.	Stanwell Creek	WCC	\$150,000	\$20,000	\$426,015	2	2	4	2	3	0	13.8	\$2.45	96	-
19f	Erect interpretative signs to provide information to visitors and residents of the importance of the potential habitat for threatened birds (Australasian Bittern and Black Bittern).	Bellambi Gully	WCC, DECC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	3	0	9.6	\$2.43	97	-
19g	Erect interpretative signs to provide information to visitors and residents of the importance of the potential habitat for threatened birds (Australasian Bittern and Black Bittern).	Bellambi Lagoon	WCC, DECC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	3	0	9.6	\$2.43	97	-
19h	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC	Hargraves Creek	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	3	0	9.6	\$2.43	97	-
19i	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC	Collins Creek	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	3	0	9.6	\$2.43	97	-
19j	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC	Bellambi Gully	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	3	0	9.6	\$2.43	97	-
19l	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC	Tom Thumb Lagoon	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	3	0	9.6	\$2.43	97	-
19r	Erect interpretative signs to provide information to visitors and residents of the importance of the potential habitat for all species of threatened shorebirds and migratory waders.	All estuaries	WCC, DECC,	\$2,000	\$500	\$8,900	3	3	0	0	3	0	9.6	\$2.43	97	-
41	Provide ongoing support and opportunities for the community to participate in restoration and management of aquatic, wetland and wildlife habitats (eg. through WCC's Bushcare program).	All estuaries	WCC, CVA, DECC, DPI, SRCMA	\$5,000	\$2,500	\$39,502	2	2	2	0	2	2	11.1	\$2.41	104	-
36a	Undertake restoration of Swamp Oak Floodplain EEC including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users.	Stanwell Creek	WCC, CVA, DECC	\$15,000	\$1,500	\$35,701	3	3	2	0	2	0	10.8	\$2.37	105	-
36b	Undertake restoration of Swamp Oak Floodplain EEC including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users.	Bellambi Lagoon	WCC, CVA, DECC	\$15,000	\$1,500	\$35,701	3	3	2	0	2	0	10.8	\$2.37	105	-
36d	Undertake restoration of Bangalay Sand Forest EEC including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users.	Bellambi Lagoon	WCC, DECC, SRCMA	\$15,000	\$1,500	\$35,701	3	3	2	0	2	0	10.8	\$2.37	105	-
78	Formalise the beach access and revegetate at area of erosion H3 (refer Figures F1-F10 in the EPS report).	Hargraves Creek	WCC, SRCMA	\$7,500	\$500	\$14,400	3	2	3	0	1	0	9.8	\$2.36	108	-

Management Action No	Management Action	Estuary	Responsibility & Involvement	Capital Cost	Recurrent Cost	NPV	Flora Impact - Aquatic and Terrestrial	Fauna Impact - Aquatic, Terrestrial, Avifauna	Water & Sediment Quality Impact	Flooding Impact	Human User Impact	Cultural Heritage Impact	Benefit Index	Benefit Index / Log NPV	Rank	Notes
103	Require water quality, as well as quantity, be considered in the design of any flood detention structures.	All estuaries	WCC	\$1,000	\$1,000	\$14,801	2	2	3	0	2	0	9.7	\$2.33	109	-
36c	Undertake restoration of Swamp Oak Floodplain EEC including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users.	Tom Thumb Lagoon	WCC, CVA, DECC	\$20,000	\$2,500	\$54,502	3	3	2	0	2	0	10.8	\$2.28	110	-
70a	Stabilise dunes near the estuary entrance in accordance with best management practice.	Flanagans Creek	WCC	\$15,000	\$3,000	\$56,402	4	2	2	0	2	0	10.8	\$2.27	111	-
70b	Stabilise dunes near the estuary entrance in accordance with best management practice.	Whartons Creek	WCC	\$15,000	\$3,000	\$56,402	4	2	2	0	2	0	10.8	\$2.27	111	-
70c	Stabilise dunes near the estuary entrance in accordance with best management practice.	Hargraves Creek	WCC	\$15,000	\$3,000	\$56,402	4	2	2	0	2	0	10.8	\$2.27	111	-
17c	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Bellambi Lagoon	WCC, SRCMA	\$5,000	\$500	\$11,900	3	2	0	0	0	3	9.25	\$2.27	114	-
10b	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	3	3	3	0	0	0	9.9	\$2.22	115	-
10c	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Collins Creek	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	3	3	3	0	0	0	9.9	\$2.22	115	-
10d	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	3	3	3	0	0	0	9.9	\$2.22	115	-
10e	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	3	3	3	0	0	0	9.9	\$2.22	115	-
10f	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	3	3	3	0	0	0	9.9	\$2.22	115	-
10g	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Swamp Oak Floodplain EEC.	Stanwell Creek	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	3	0	0	0	9.9	\$2.22	115	-
10h	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Swamp Oak Floodplain EEC.	Bellambi Lagoon	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	3	0	0	0	9.9	\$2.22	115	-
10i	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Swamp Oak Floodplain EEC.	Tom Thumb Lagoon	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	3	0	0	0	9.9	\$2.22	115	-
10j	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Bangalay Sand Forest EEC.	Bellambi Lagoon	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	3	0	0	0	9.9	\$2.22	115	-
12c	Protect mangroves from human access/trampling and weed invasion.	Tom Thumb Lagoon	WCC, CVA, SRCMA	\$1,000	\$0	\$1,000	2	2	2	0	0	0	6.6	\$2.20	124	-
47	Prepare and adopt a Soil and Water Management Policy that requires submission of a Construction Environmental Management Plan (including a Soil and Water Management Plan) with a Development Application setting out how erosion and sediment control, water quality and water quantity will be managed during both the construction and operational stages to achieve the required water quality standards.	All estuaries	WCC	\$20,000	\$1,000	\$33,801	3	2	4	0	0	0	9.9	\$2.19	125	In progress
19b	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc	Hargraves Creek	WCC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	2	0	8.6	\$2.18	126	-
19c	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc	Bellambi Gully	WCC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	2	0	8.6	\$2.18	126	-
19d	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc	Collins Creek	WCC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	2	0	8.6	\$2.18	126	-
19e	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc	Stanwell Creek	WCC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	2	0	8.6	\$2.18	126	-
19m	Erect interpretative signs to provide information to visitors and residents of the importance of the Swamp Oak Floodplain EEC.	Stanwell Creek	WCC, CVA, DECC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	2	0	8.6	\$2.18	126	-
19n	Erect interpretative signs to provide information to visitors and residents of the importance of the Swamp Oak Floodplain EEC.	Bellambi Lagoon	WCC, CVA, DECC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	2	0	8.6	\$2.18	126	-
19o	Erect interpretative signs to provide information to visitors and residents of the importance of the Swamp Oak Floodplain EEC.	Tom Thumb Lagoon	WCC, CVA, DECC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	2	0	8.6	\$2.18	126	-
19p	Erect educational signs to provide information to visitors and residents of the importance of the Bangalay Sand Forest EEC.	Bellambi Lagoon	WCC, DECC, SRCMA	\$2,000	\$500	\$8,900	3	3	0	0	2	0	8.6	\$2.18	126	-
22a	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing evegetation	Hargraves Creek	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	4	4	0	0	2	0	10.8	\$2.18	134	-
22b	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing evegetation	Stanwell Creek	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	4	4	0	0	2	0	10.8	\$2.18	134	-
22c	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing evegetation	Collins Creek	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	4	4	0	0	2	0	10.8	\$2.18	134	-
22d	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing evegetation	Bellambi Gully	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	4	4	0	0	2	0	10.8	\$2.18	134	-
22e	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing evegetation	Bellambi Lagoon	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	4	4	0	0	2	0	10.8	\$2.18	134	-
22f	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing evegetation	Tom Thumb Lagoon	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	4	4	0	0	2	0	10.8	\$2.18	134	-
49	Establish water quality standards for stormwater runoff from new development considering the estuary's temporal response to pollutant inputs (daily, weekly or monthly) and within the framework of the cumulative impact assessment.	All estuaries	WCC	\$10,000	\$2,000	\$37,601	3	2	4	0	0	0	9.9	\$2.16	140	-
20a	Protect potential riparian habitat for the Red Crowned Toadlet by minimising disturbance to the upper reaches of the creeks	Hargraves Creek	WCC, DECC, SRCMA	\$7,500	\$500	\$14,400	2	3	3	0	0	0	8.8	\$2.12	141	-

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20b	Protect potential riparian habitat for the Red Crowned Toadlet by minimising disturbance to the upper reaches of the creeks	Stanwell Creek	WCC, DECC, SRCMA	\$7,500	\$500	\$14,400	2	3	3	0	0	0	8.8	\$2.12	141	-
33a	Protect saltmarsh from disturbance through provision of signage and active management.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	4	2	0	0	2	0	8.6	\$2.11	143	-
33b	Protect saltmarsh from disturbance through provision of signage and active management.	Collins Creek	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	4	2	0	0	2	0	8.6	\$2.11	143	-
33c	Protect saltmarsh from disturbance through provision of signage and active management.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	4	2	0	0	2	0	8.6	\$2.11	143	-
33d	Protect saltmarsh from disturbance through provision of signage and active management.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	4	2	0	0	2	0	8.6	\$2.11	143	-
83	Supplement the erosion protection (gabion baskets) provided near the entrance to the estuary with revegetation.	Whartons Creek	WCC, SRCMA	\$10,000	\$2,500	\$44,502	2	3	2	0	2	0	9.7	\$2.09	147	-
33e	Protect saltmarsh from disturbance through provision of signage and active management.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$7,500	\$500	\$14,400	4	2	0	0	2	0	8.6	\$2.07	148	-
76	Fence area of bank erosion H1 (refer Figures F1-F10 in the EPS report) and revegetate the understorey vegetation to reduce the extent and rate of erosion.	Hargraves Creek	WCC, SRCMA	\$15,000	\$3,000	\$56,402	3	2	3	0	1	0	9.8	\$2.06	149	-
77	Establish a fenced revegetated riparian zone at area of bank erosion H2 (refer Figures F1-F10 in the EPS report) to reduce the extent and rate of erosion.	Hargraves Creek	WCC, SRCMA	\$15,000	\$3,000	\$56,402	3	2	3	0	1	0	9.8	\$2.06	149	-
71c	Investigate, verify and rectify potential erosion sites in upstream catchments.	Hargraves Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	2	2	3	0	2	0	9.7	\$2.01	151	-
71d	Investigate, verify and rectify potential erosion sites in upstream catchments.	Flanagans Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	2	2	3	0	2	0	9.7	\$2.01	151	-
71e	Investigate, verify and rectify potential erosion sites in upstream catchments.	Slacky Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	2	2	3	0	2	0	9.7	\$2.01	151	-
71g	Investigate, verify and rectify potential erosion sites in upstream catchments.	Collins Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	2	2	3	0	2	0	9.7	\$2.01	151	-
71h	Investigate, verify and rectify potential erosion sites in upstream catchments.	Stoney Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	2	2	3	0	2	0	9.7	\$2.01	151	-
109	Require, through an LGA-wide DCP, that foreshore protection to control erosion conforms to the VMP and be of a standardised type utilising local native plants with harder materials, such as timber or rock, only where necessary.	All estuaries	WCC	\$15,000	\$5,000	\$84,004	2	2	2	0	2	1	9.85	\$2.00	156	-
67	Investigate options to mitigate water quality impacts from the sewer overflow upstream of Tom Thumb Lagoon and implement when possible.	Tom Thumb Lagoon	SWC, WCC	\$10,000	\$5,000	\$79,004	2	2	3	0	2	0	9.7	\$1.98	157	In progress
19s	Erect signage at waterway access points on the need to protect the waterway from litter.	All estuaries	WCC, SRCMA	\$2,500	\$1,500	\$23,201	2	1	3	0	2	0	8.6	\$1.97	158	-
80	Extend the existing rock toe protection downstream to area of bank erosion SW2 (refer Figures F1-F10 in the EPS report) . Provide revegetation and fencing to control access along the downstream section.	Stanwell Creek	WCC, SRCMA	\$40,000	\$5,000	\$109,004	3	2	3	0	1	0	9.8	\$1.95	159	-
71f	Investigate, verify and rectify potential erosion sites in upstream catchments.	Whartons Creek	WCC, SRCMA	\$40,000	\$5,000	\$109,004	2	2	3	0	2	0	9.7	\$1.93	160	-
53	Retrofit existing urban development with stormwater treatment measures such as trash racks, gross pollutant traps and wetlands (where space permits).	All estuaries	WCC, SRCMA	\$150,000	\$10,000	\$288,007	2	1	2	2	3	0	10.5	\$1.92	161	-
63	Educate specific industry groups and developers of best management practices for minimising polluted runoff.	All estuaries	WCC, SRCMA	\$10,000	\$2,500	\$44,502	2	1	3	0	2	0	8.6	\$1.85	162	-
79	Provide rock toe protection at area of bank erosion SW1 (refer Figures F1-F10 in the EPS report) , and revegetate upper bank with understorey and shrub species. Extend downstream through the minimally active zone.	Stanwell Creek	WCC, SRCMA	\$65,000	\$10,000	\$203,007	3	2	3	0	1	0	9.8	\$1.85	163	-
51	Permit development on unsewered urban or rural lots only where there is sufficient area of suitable soil away from drainage lines to satisfactorily dispose of septic effluent on site.	All estuaries	WCC	\$1,000	\$1,000	\$14,801	2	1	4	0	0	0	7.7	\$1.85	164	In progress
71a	Investigate, verify and rectify potential erosion sites in upstream catchments.	Bellambi Gully	WCC, SRCMA	\$75,000	\$10,000	\$213,007	2	2	3	0	2	0	9.7	\$1.82	165	-
71b	Investigate, verify and rectify potential erosion sites in upstream catchments.	Bellambi Lagoon	WCC, SRCMA	\$75,000	\$10,000	\$213,007	2	2	3	0	2	0	9.7	\$1.82	165	-
95	Ensure sufficient and appropriate foreshore land continues to be reserved for access and facilities.	All estuaries	WCC	\$5,000	\$5,000	\$74,004	0	0	0	0	5	3	8.75	\$1.80	167	-
21a	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Hargraves Creek	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	2	0	-1	0	7.8	\$1.75	168	-
21b	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Stanwell Creek	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	2	0	-1	0	7.8	\$1.75	168	-
21c	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Collins Creek	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	2	0	-1	0	7.8	\$1.75	168	-
21d	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Bellambi Gully	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	2	0	-1	0	7.8	\$1.75	168	-
21e	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Bellambi Lagoon	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	2	0	-1	0	7.8	\$1.75	168	-
21f	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Tom Thumb Lagoon	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	3	3	2	0	-1	0	7.8	\$1.75	168	-
85	Formalise a beach access on the right bank and revegetate disturbed areas to reduce erosion.	Bellambi Lagoon	WCC, SRCMA	\$5,000	\$500	\$11,900	3	2	1	0	0	0	6.6	\$1.62	174	-
60	Develop SCAMPS in all catchments where faecal contamination is an issue, and address capacity of systems.	All estuaries	SWC	\$100,000	\$50,000	\$790,037	2	1	2	0	4	0	9.5	\$1.61	175	-
20c	Protect potential riparian habitat for the Red Crowned Toadlet by minimising disturbance to the upper reaches of the creeks	Bellambi Gully	WCC, DECC, SRCMA	\$7,500	\$500	\$14,400	2	2	2	0	0	0	6.6	\$1.59	176	-
20d	Protect potential riparian habitat for the Red Crowned Toadlet by minimising disturbance to the upper reaches of the creeks	Bellambi Lagoon	WCC, DECC, SRCMA	\$7,500	\$500	\$14,400	2	2	2	0	0	0	6.6	\$1.59	176	-
54	Regularly inspect and audit construction sites to monitor compliance with water quality criteria attached to the development consent.	All estuaries	WCC	\$5,000	\$20,000	\$281,015	2	2	2	0	2	0	8.6	\$1.58	178	-
112	Educate the community and, in particular, the landholders adjacent to the waterway or in the first row of houses behind foreshore roadways, on the value of not clearing their land or waterfront reserves to improve their own views, and the penalties for illegal clearing. Regenerate illegally cleared areas and erect highly visible fencing (eg. orange safety fencing) and signage as deterrents.	All estuaries	WCC, SRCMA	\$10,000	\$20,000	\$286,015	3	3	0	0	2	0	8.6	\$1.58	179	-
111	Provide local native trees, shrubs and other plants for use on waterfront properties.	All estuaries	WCC	\$0	\$5,000	\$69,004	2	2	1	0	2	0	7.5	\$1.55	180	-

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72	Undertake an erosion and sedimentation survey (including catchment, in-stream and foreshores) assessing sediment yield of sources, sediment quality and rate of infilling. Remediate sources of high risk to the estuary.	All estuaries	WCC, SRCMA	\$50,000	\$10,000	\$188,007	1	1	4	0	0	1	7.85	\$1.49	181	-
91	Adopt a precautionary approach of accepting a lower level of risk (ie. a wider safety margin) for managing existing and proposed land and waterway uses affecting highly valued environmentally sensitive components of the estuarine ecosystem.	All estuaries	WCC	\$5,000	\$1,500	\$25,701	1	1	1	1	1	1	6.55	\$1.49	182	-
84	Restrict access to, and revegetate, the left bank between the entrance to Bulli Beach Holiday Park and the footbridge.	Whartons Creek	WCC, SRCMA	\$15,000	\$2,000	\$42,601	2	2	2	0	0	0	6.6	\$1.43	183	-
105	Carry out entrance management as outlined in adopted entrance management policies	All estuaries	WCC	\$15,000	\$5,000	\$84,004	-1	-1	2	5	3	-1	6.75	\$1.37	184	-
39	Promote public involvement in restoration and bush regeneration activities.	Bellambi Lagoon	WCC, DECC, SRCMA	\$1,500	\$500	\$8,400	2	1	0	0	2	0	5.3	\$1.35	185	-
37a	Promote public involvement in restoration and bush regeneration activities.	Stanwell Creek	WCC, CVA, DECC	\$1,500	\$500	\$8,400	2	1	0	0	2	0	5.3	\$1.35	185	-
37b	Promote public involvement in restoration and bush regeneration activities.	Bellambi Lagoon	WCC, CVA, DECC	\$1,500	\$500	\$8,400	2	1	0	0	2	0	5.3	\$1.35	185	-
37c	Promote public involvement in restoration and bush regeneration activities.	Tom Thumb Lagoon	WCC, CVA, DECC	\$1,500	\$500	\$8,400	2	1	0	0	2	0	5.3	\$1.35	185	-
17a	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Stanwell Creek	WCC	\$5,000	\$500	\$11,900	3	2	0	0	0	0	5.5	\$1.35	189	-
17b	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Bellambi Gully	WCC, SRCMA	\$5,000	\$500	\$11,900	3	2	0	0	0	0	5.5	\$1.35	189	-
17d	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Hargraves Creek	WCC, SRCMA	\$5,000	\$500	\$11,900	3	2	0	0	0	0	5.5	\$1.35	189	-
17e	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Collins Creek	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	3	2	0	0	0	0	5.5	\$1.35	189	-
12a	Protect mangroves from human access/trampling and weed invasion.	Bellambi Gully	WCC, CVA, SRCMA	\$3,000	\$0	\$3,000	2	1	1	0	0	0	4.4	\$1.27	193	-
29a	Investigate and manage water quality and hydrological impacts on saltmarsh	Hargraves Creek	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	2	1	1	0	0	0	4.4	\$1.27	193	-
29b	Investigate and manage water quality and hydrological impacts on saltmarsh	Collins Creek	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	2	1	1	0	0	0	4.4	\$1.27	193	-
29c	Investigate and manage water quality and hydrological impacts on saltmarsh	Bellambi Gully	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	2	1	1	0	0	0	4.4	\$1.27	193	-
29d	Investigate and manage water quality and hydrological impacts on saltmarsh	Bellambi Lagoon	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	2	1	1	0	0	0	4.4	\$1.27	193	-
12b	Protect mangroves from human access/trampling and weed invasion.	Bellambi Lagoon	WCC, CVA, SRCMA	\$4,000	\$0	\$4,000	2	1	1	0	0	0	4.4	\$1.22	198	-
108	Prepare a Visual Management Plan (VMP) to maintain significant views and vistas and require, through planning instruments, development control plans and design guidelines that all building and development applications conform to the VMP.	All estuaries except Tom Thumb Lagoon	WCC	\$10,000	\$1,000	\$23,801	0	0	0	0	4	1	5.25	\$1.20	199	-
97	Classify Council-owned land with open space or conservation value as community land under the Local Government Act.	All estuaries	WCC	\$1,000	\$1,000	\$14,801	0	0	0	0	5	0	5	\$1.20	200	In progress
93	Survey public foreshore structures and assess whether the location and extent is appropriate. Require the removal of unauthorised private foreshore structures where they cause a navigation hazard, are unsafe, or exacerbate erosion.	All estuaries	WCC	\$7,500	\$1,000	\$21,301	0	0	0	0	5	0	5	\$1.16	201	-
57	Conduct a pollutant audit and remediate inappropriate practices.	All estuaries	WCC	\$25,000	\$2,000	\$52,601	1	1	2	0	1	0	5.4	\$1.14	202	In progress
75	Monitor minor erosion in the vicinity of the footbridge to ensure it does not worsen and impact the footbridge in the future. Remediate erosion if considered necessary.	Bellambi Gully	WCC, SRCMA	\$0	\$750	\$10,351	1	1	1	0	1	0	4.3	\$1.07	203	-
104	Install rainfall, stream flow gauges and water level recorders where required.	All estuaries	WCC	\$25,000	\$5,000	\$94,004	0	0	2	2	1	0	5.2	\$1.05	204	-
107	Prepare and adopt a Visual Management System for the LGA setting out the methodology for undertaking visual assessments	All estuaries	WCC	\$50,000	\$5,000	\$119,004	0	0	0	0	4	1	5.25	\$1.03	205	-
96	Maximise public ownership and appropriate access to Council and Crown foreshore land.	All estuaries	WCC	\$5,000	\$5,000	\$74,004	0	0	0	0	5	0	5	\$1.03	206	-
94	Based on the access and demand survey, provide facilities such as parking, litter collection, amenities and walking trails.	All estuaries	WCC	\$15,000	\$5,000	\$84,004	0	0	0	0	5	0	5	\$1.02	207	-
110	Provide foreshore viewing platforms if required.	All estuaries	WCC	\$15,000	\$5,000	\$84,004	0	0	0	0	5	0	5	\$1.02	207	-
69	Undertake a desktop assessment of existing water quality discharge data to investigate the potential for water quality improvement in TTL as a result of the closure of the Tin Mill.	Tom Thumb Lagoon	WCC	\$2,500	\$0	\$2,500	1	1	1	0	0	0	3.3	\$0.97	209	-
106	Prepare flood awareness brochures for distribution to residents in flood-prone areas.	All estuaries	WCC	\$7,500	\$2,500	\$42,002	0	0	0	2	2	0	4	\$0.87	210	-
101	Implement relevant actions from Floodplain Management Plans, taking into consideration their likely impact on environmental, social and cultural values.	All estuaries	WCC	\$150,000	\$50,000	\$840,037	0	0	0	5	0	0	5	\$0.84	211	-
58	Identify and map on Council's GIS the location of all point source discharges to the creeks.	All estuaries	WCC	\$50,000	\$10,000	\$188,007	1	1	2	0	0	0	4.4	\$0.83	212	-
31a	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-
31b	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Collins Creek	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-
31c	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-
31d	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-
31e	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-

Management Action No	Management Action	Estuary	Responsibility & Involvement	Capital Cost	Recurrent Cost	NPV	Flora Impact - Aquatic and Terrestrial	Fauna Impact - Aquatic, Terrestrial, Avifauna	Water & Sediment Quality Impact	Flooding Impact	Human User Impact	Cultural Heritage Impact	Benefit Index	Benefit Index / Log NPV	Rank	Notes
32a	Allow areas of saltmarsh to regenerate naturally where possible.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-
32b	Allow areas of saltmarsh to regenerate naturally where possible.	Collins Creek	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-
32c	Allow areas of saltmarsh to regenerate naturally where possible.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-
32d	Allow areas of saltmarsh to regenerate naturally where possible.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-
32e	Allow areas of saltmarsh to regenerate naturally where possible.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	2	1	0	0	0	0	3.3	\$0.80	213	-
23a	Investigate, and where possible implement, measures to control or eradicate the introduced Mosquito fish.	Flanagans Creek	WCC, DECC	\$5,000	\$0	\$5,000	1	1	0	0	0	0	2.2	\$0.59	223	-
23b	Investigate, and where possible implement, measures to control or eradicate the introduced Mosquito fish.	Collins Creek	WCC, DECC	\$5,000	\$0	\$5,000	1	1	0	0	0	0	2.2	\$0.59	223	-
23c	Investigate, and where possible implement, measures to control or eradicate the introduced Mosquito fish.	Bellambi Gully	WCC, DECC	\$5,000	\$0	\$5,000	1	1	0	0	0	0	2.2	\$0.59	223	-
23d	Investigate, and where possible implement, measures to control or eradicate the introduced Mosquito fish.	Bellambi Lagoon	WCC, DECC	\$5,000	\$0	\$5,000	1	1	0	0	0	0	2.2	\$0.59	223	-
13	Consider the impacts of climate change (particularly sea level rise) in the assessment of proposed developments, and when identifying and prioritizing sites for regeneration works.	All estuaries	WCC, SRCMA	\$2,000	\$500	\$8,900	1	1	0	0	0	0	2.2	\$0.56	227	-
28a	Monitor the presence, density, levels of activity, and potential impacts of feral animals, in particular foxes and cats, on threatened Bittern species.	Bellambi Gully	WCC, DECC	\$5,000	\$0	\$5,000	0	1	0	0	0	0	1.1	\$0.30	228	-
28b	Monitor the presence, density, levels of activity, and potential impacts of feral animals, in particular foxes and cats, on threatened Bittern species.	Bellambi Lagoon	WCC, DECC	\$5,000	\$0	\$5,000	0	1	0	0	0	0	1.1	\$0.30	228	-
26	Reduce disturbance to coastal feeding, nesting and roosting areas of threatened shorebirds and migratory waders by implementing a protection zone around them (500m radius), and restricting beach-combing, fishing, dog-walking, horse-riding, 4WD vehicles and other disturbing activities in the immediate vicinity of the potential habitat. Initial focus to be on the Sooty Oystercatcher habitat at Stanwell Creek	All estuaries, particularly Stanwell Creek	WCC, DECC	\$10,000	\$2,000	\$37,601	0	2	0	0	-1	0	1.2	\$0.26	230	-
16a	Investigate and implement actions to reduce feral species, if warranted.	Bellambi Lagoon	WCC	\$5,000	\$1,000	\$18,801	0	1	0	0	0	0	1.1	\$0.26	231	-
16b	Investigate and implement actions to reduce feral species, if warranted.	Tom Thumb Lagoon	WCC	\$5,000	\$1,000	\$18,801	0	1	0	0	0	0	1.1	\$0.26	231	-
126	Implement the Monitoring Plan detailed in Chapter 8 of the EMP (or alternative).	All estuaries	WCC	\$10,000	\$5,000	\$79,004	0	0	0	0	0	0	0	\$0.00	233	-
127	Develop appropriate community monitoring projects.	All estuaries	WCC, SRCMA	\$10,000	\$10,000	\$148,007	0	0	0	0	0	0	0	\$0.00	233	-
113	Prepare entrance management policy in consultation with the community, the Estuary Management Committee, and Councillors.	Bellambi Lagoon	WCC	\$30,000	\$15,000	\$237,011	-3	-3	-3	4	0	1	-4.65	-\$0.87	235	-
114	Where appropriate, implement entrance management policy, using the media to publicise entrance opening events.	Bellambi Lagoon	WCC	\$0	\$10,000	\$138,007	-3	-3	-3	4	0	1	-4.65	-\$0.90	236	-
8	Carry out snag removal only where risks to public safety occur.	All estuaries	WCC, DPI	\$5,000	\$0	\$5,000	-4	-4	0	1	-3	0	-10.8	-\$2.92	237	-
2	Where alternative siting for a development is not appropriate, adopt the principle of environmental compensation in the approval process for any activity that causes unavoidable damage to any estuarine habitat or catchment habitat that is of importance to the estuary.	All estuaries	WCC	\$2,500	\$2,500	\$37,002	-3	-3	0	0	-3	-3	-13.35	-\$2.92	238	-



Appendix B  
Estuary Management Plan  
Management Actions Ordered by Estuary

Table 7.2 Management Actions ordered by Estuary and Rank

Management Action No	Management Action	Estuary	Responsibility & Involvement	Capital Cost	Recurrent Cost	NPV	Rank	Notes
1	Ensure estuaries are appropriately zoned (prohibiting certain development types), dedicated and/or reserved, and appropriate development controls are implemented.	All estuaries	WCC	\$1,000	\$0	\$1,000	1	In progress
5	Adopt riparian objectives and control measures as detailed in Council's Riparian Development Control Plan.	All estuaries	WCC, SRCMA	\$2,000	\$0	\$2,000	2	-
3	Review public ownership of foreshore and riparian areas whenever opportunities arise through rezoning, development approvals or acquisition (including like-for-like contributions from developers/landowners).	All estuaries	WCC	\$1,000	\$1,000	\$14,801	3	In progress
4	Introduce appropriate zoning or an LEP clause requiring consent from Council for any development within reserves and buffer zones, except for fencing, revegetation or any works contained in an Estuary Management Plan and prohibiting certain development types altogether.	All estuaries	WCC	\$1,000	\$0	\$1,000	6	In progress
52	Prepare Stormwater Management Plans for existing developed areas within the framework of the cumulative impact assessment.	All estuaries	WCC	\$10,000	\$2,000	\$37,601	8	-
119	Develop an education brochure outlining the impacts of human activity on estuary condition and the actions that can be taken at a personal level to maintain estuary health. Distribute with rates notices and make available at frequent visitation points.	All estuaries	WCC, SRCMA	\$7,500	\$1,000	\$21,301	13	-
45	Develop and adopt water quality standards (as per ANZECC 2000) for the estuary to identify appropriate standards for aquatic ecosystem health.	All estuaries	WCC	\$15,000	\$1,000	\$28,801	20	In progress
50	Adopt water-sensitive urban design principles, using the LEP or a separate LGA-wide DCP.	All estuaries	WCC	\$10,000	\$2,000	\$37,601	22	In progress
92	Require that a Local Environmental Study be prepared for a major LEP or rezoning proposal for any area within or adjoining an estuary. The LES should consider potential impacts on estuarine values including the ecosystem, threatened species, water quality, cultural heritage, foreshore and estuary access and usage, population levels with tourist influx, public amenity, fishing and acid sulphate soils.	All estuaries	Proponent	\$100,000	\$0	\$100,000	23	-
11	Remove non-native and noxious species and revegetate and regenerate using local native species.	All estuaries	WCC, CVA, SRCMA	\$10,000	\$1,000	\$23,801	24	-
65	Monitor estuarine water and sediment quality and ecosystem health, and catchment water and sediment quality, in accordance with the Monitoring Plan in Chapter 8 of the EMP.	All estuaries	WCC	\$2,500	\$15,000	\$209,511	37	-
48	Incorporate in the Soil and Water Management Policy a condition that pre- and post-development monitoring be undertaken to prove compliance with the standards at the developer's cost.	All estuaries	WCC	\$2,000	\$0	\$2,000	48	-
98	Implement the Coastal Lands Protection Scheme	All estuaries	WCC	\$0	\$2,000	\$27,601	49	-
117	Distribute an Estuary Management Plan summary to local residents and make the full plan available for public perusal at any time. Consult the local community and other stakeholders prior to implementing management actions.	All estuaries	WCC	\$5,000	\$2,000	\$32,601	50	-
121	Use the local media to publicise Estuary Management Plans, the results of monitoring programs, and issues of concern as they arise.	All estuaries	WCC	\$5,000	\$2,000	\$32,601	50	-
118	Maintain an action plan to log the progress and success of the implementation of estuary management plan actions. Update the plan after each Estuary Management Committee meeting and distribute to interested parties, including the media, on request.	All estuaries	WCC	\$1,000	\$2,500	\$35,502	56	-
59a	Include acid sulphate soil provisions in LEP. Identify any existing acid sulphate drainage, remediate and, if required, prepare a plan for ongoing management.	All estuaries	WCC	\$5,000	\$5,000	\$74,004	57	In progress
100	Develop Floodplain Management Plans that take into consideration the effect of proposed management actions on environmental, social and cultural values.	All estuaries	WCC	\$150,000	\$25,000	\$495,019	60	In progress
116	Publicise the dangers and risks of illegally opening estuary entrances through the media, and include warnings on signage adjacent to estuary entrances or at beach reserve carparks.	All estuaries	WCC	\$2,000	\$500	\$8,900	67	-
99	Prepare handouts for distribution at caravan parks and other tourist accommodation on the need for foreshore users to dispose of bait bags, drink bottles and other litter appropriately.	All estuaries	WCC, SRCMA	\$5,000	\$1,000	\$18,801	74	-
122	Use Council's web site as a means of distributing all the above educational material.	All estuaries	WCC	\$1,000	\$5,000	\$70,004	75	-
120	Develop a plan, preferably using a Geographical Information System, to be used in conjunction with the action plan, showing land and waterway uses and current planning and development activities occurring in the estuary and the catchment.	All estuaries	WCC	\$2,000	\$5,000	\$71,004	76	-
44	Establish Standard Operating Procedures for Council staff to follow to prevent mowing/slashing of sensitive vegetation (including EECs), inappropriate use of herbicides/pesticides, etc, incorporating maps or photos of the sensitive habitats. Investigate Council's control over inappropriate aerial herbicide spraying undertaken by the Illawarra District Noxious Weed Authority (IDNWA).	All estuaries	WCC, IDNWA	\$2,500	\$500	\$9,400	77	-
6	Negotiate property vegetation plans agreements and property management plans with owners of land with vegetation communities plant and animal species and/or ecological communities or populations of significant conservation value.	All estuaries	WCC, SRCMA	\$5,000	\$5,000	\$74,004	78	-
46	Calculate pollutant inventories and budgets for existing land uses and prepare land and water capability assessments to establish total allowable pollutant loads and other relevant loads or factors.	All estuaries	WCC	\$40,000	\$10,000	\$178,007	79	-
62	Educate the community on environmentally responsible practices around the house that protect water quality by developing a brochure for distribution to all residents, recommending measures including: composting grass clippings; using organic rather than synthetic fertilisers; applying fertiliser sparingly and according to soil requirements; vegetating bare soil areas; using phosphate-free detergents; washing cars on grass; capturing pet droppings; and not dumping domestic refuse, including grass clippings, on the foreshores and riverbanks or in the bush.	All estuaries	WCC, SRCMA	\$5,000	\$2,000	\$32,601	82	In progress
90	Investigate sites and areas of potential cultural heritage significance (Aboriginal and European, including the campsites near Stanwell Creek) and protect as necessary.	All estuaries	WCC, DECC	\$5,000	\$1,000	\$18,801	84	-
40	Initiate community awareness programs that highlight the presence of threatened species populations and catchment management approaches to improving stormwater quality, habitat retention and management.	All estuaries	WCC, DECC, SRCMA	\$5,000	\$1,000	\$18,801	85	-
102	Prepare entrance management policies consistent with Floodplain Management Plans and ensure entrance management accommodates ecological requirements, where possible.	All estuaries	WCC	\$25,000	\$5,000	\$94,004	86	-
19r	Erect interpretative signs to provide information to visitors and residents of the importance of the potential habitat for all species of threatened shorebirds and migratory waders.	All estuaries	WCC, DECC,	\$2,000	\$500	\$8,900	96	-
41	Provide ongoing support and opportunities for the community to participate in restoration and management of aquatic, wetland and wildlife habitats (eg. through WCC's Bushcare program).	All estuaries	WCC, CVA, DECC, DPI, SRCMA	\$5,000	\$2,500	\$39,502	103	-
103	Require water quality, as well as quantity, be considered in the design of any flood detention structures.	All estuaries	WCC	\$1,000	\$1,000	\$14,801	108	-
47	Prepare and adopt a Soil and Water Management Policy that requires submission of a Construction Environmental Management Plan (including a Soil and Water Management Plan) with a Development Application setting out how erosion and sediment control, water quality and water quantity will be managed during both the construction and operational stages to achieve the required water quality standards.	All estuaries	WCC	\$20,000	\$1,000	\$33,801	124	In progress
49	Establish water quality standards for stormwater runoff from new development considering the estuary's temporal response to pollutant inputs (daily, weekly or monthly) and within the framework of the cumulative impact assessment.	All estuaries	WCC	\$10,000	\$2,000	\$37,601	139	-
109	Require, through an LGA-wide DCP, that foreshore protection to control erosion conforms to the VMP and be of a standardised type utilising local native plants with harder materials, such as timber or rock, only where necessary.	All estuaries	WCC	\$15,000	\$5,000	\$84,004	155	-
19s	Erect signage at waterway access points on the need to protect the waterway from litter.	All estuaries	WCC, SRCMA	\$2,500	\$1,500	\$23,201	157	-
53	Retrofit existing urban development with stormwater treatment measures such as trash racks, gross pollutant traps and wetlands (where space permits).	All estuaries	WCC, SRCMA	\$150,000	\$10,000	\$288,007	160	-

Management Action No	Management Action	Estuary	Responsibility & Involvement	Capital Cost	Recurrent Cost	NPV	Rank	Notes
63	Educate specific industry groups and developers of best management practices for minimising polluted runoff.	All estuaries	WCC, SRCMA	\$10,000	\$2,500	\$44,502	161	-
51	Permit development on unsewered urban or rural lots only where there is sufficient area of suitable soil away from drainage lines to satisfactorily dispose of septic effluent on site.	All estuaries	WCC	\$1,000	\$1,000	\$14,801	163	In progress
95	Ensure sufficient and appropriate foreshore land continues to be reserved for access and facilities.	All estuaries	WCC	\$5,000	\$5,000	\$74,004	166	-
60	Develop SCAMPS in all catchments where faecal contamination is an issue, and address capacity of systems.	All estuaries	SWC	\$100,000	\$50,000	\$790,037	175	-
54	Regularly inspect and audit construction sites to monitor compliance with water quality criteria attached to the development consent.	All estuaries	WCC	\$5,000	\$20,000	\$281,015	178	-
112	Educate the community and, in particular, the landholders adjacent to the waterway or in the first row of houses behind foreshore roadways, on the value of not clearing their land or waterfront reserves to improve their own views, and the penalties for illegal clearing. Regenerate illegally cleared areas and erect highly visible fencing (eg. orange safety fencing) and signage as deterrents.	All estuaries	WCC, SRCMA	\$10,000	\$20,000	\$286,015	179	-
111	Provide local native trees, shrubs and other plants for use on waterfront properties.	All estuaries	WCC	\$0	\$5,000	\$69,004	180	-
72	Undertake an erosion and sedimentation survey (including catchment, in-stream and foreshores) assessing sediment yield of sources, sediment quality and rate of infilling. Remediate sources of high risk to the estuary.	All estuaries	WCC, SRCMA	\$50,000	\$10,000	\$188,007	181	-
91	Adopt a precautionary approach of accepting a lower level of risk (ie. a wider safety margin) for managing existing and proposed land and waterway uses affecting highly valued environmentally sensitive components of the estuarine ecosystem.	All estuaries	WCC	\$5,000	\$1,500	\$25,701	182	-
105	Carry out entrance management as outlined in adopted entrance management policies.	All estuaries	WCC	\$15,000	\$5,000	\$84,004	184	-
97	Classify Council-owned land with open space or conservation value as community land under the Local Government Act.	All estuaries	WCC	\$1,000	\$1,000	\$14,801	200	In progress
93	Survey public foreshore structures and assess whether the location and extent is appropriate. Require the removal of unauthorised private foreshore structures where they cause a navigation hazard, are unsafe, or exacerbate erosion.	All estuaries	WCC	\$7,500	\$1,000	\$21,301	201	-
57	Conduct a pollutant audit and remediate inappropriate practices.	All estuaries	WCC	\$25,000	\$2,000	\$52,601	202	In progress
104	Install rainfall, stream flow gauges and water level recorders where required.	All estuaries	WCC	\$25,000	\$5,000	\$94,004	204	-
107	Prepare and adopt a Visual Management System for the LGA setting out the methodology for undertaking visual assessments.	All estuaries	WCC	\$50,000	\$5,000	\$119,004	205	-
96	Maximise public ownership and appropriate access to Council and Crown foreshore land.	All estuaries	WCC	\$5,000	\$5,000	\$74,004	206	-
94	Based on the access and demand survey, provide facilities such as parking, litter collection, amenities and walking trails.	All estuaries	WCC	\$15,000	\$5,000	\$84,004	207	-
110	Provide foreshore viewing platforms if required.	All estuaries	WCC	\$15,000	\$5,000	\$84,004	207	-
106	Prepare flood awareness brochures for distribution to residents in flood-prone areas.	All estuaries	WCC	\$7,500	\$2,500	\$42,002	210	-
101	Implement relevant actions from Floodplain Management Plans, taking into consideration their likely impact on environmental, social and cultural values.	All estuaries	WCC	\$150,000	\$50,000	\$840,037	211	-
58	Identify and map on Council's GIS the location of all point source discharges to the creeks.	All estuaries	WCC	\$50,000	\$10,000	\$188,007	212	-
13	Consider the impacts of climate change (particularly sea level rise) in the assessment of proposed developments, and when identifying and prioritizing sites for regeneration works.	All estuaries	WCC, SRCMA	\$2,000	\$500	\$8,900	227	-
126	Implement the Monitoring Plan detailed in Chapter 8 of the EMP (or alternative).	All estuaries	WCC	\$10,000	\$5,000	\$79,004	233	-
127	Develop appropriate community monitoring projects.	All estuaries	WCC, SRCMA	\$10,000	\$10,000	\$148,007	233	-
8	Carry out snag removal only where risks to public safety occur.	All estuaries	WCC, DPI	\$5,000	\$0	\$5,000	237	-
2	Where alternative siting for a development is not appropriate, adopt the principle of environmental compensation in the approval process for any activity that causes unavoidable damage to any estuarine habitat or catchment habitat that is of importance to the estuary.	All estuaries	WCC	\$2,500	\$2,500	\$37,002	238	-
10a	Restrict or control access to sensitive estuarine habitats whilst providing appropriate access points for authorised users.	All estuaries except Tom Thumb Lagoon	WCC, CVA, SRCMA	\$10,000	\$1,000	\$23,801	5	-
66	Erect signage near the estuary entrance to inform the community about potential water quality problems and associated health risks from primary and secondary recreational contact, particularly after rainfall.	All estuaries except Tom Thumb Lagoon	WCC	\$2,500	\$500	\$9,400	14	-
64	Adopt and adapt the Beach Watch recreational water quality monitoring program (based on NHMRC 1990 and ANZECC 2000 criteria), and regularly monitor estuary water quality against these parameters. Publish the results on signage near the estuaries and on Council's website.	All estuaries except Tom Thumb Lagoon	WCC	\$1,000	\$15,000	\$208,011	36	-
43	Erect signage adjacent to sensitive habitats to inform Council staff not to mow/slash the vegetation.	All estuaries except Tom Thumb Lagoon	WCC	\$2,000	\$500	\$8,900	47	-
42	Erect appropriate barriers around foreshore vegetation to prevent mowing by Council outdoor staff.	All estuaries except Tom Thumb Lagoon	WCC	\$10,000	\$500	\$16,900	61	-
115	Establish a monitoring program to record date of opening and closing, nature of opening (natural or manual), location and width across the entrance dune, ocean water level, width and depth of channel development with time, estuary water levels through time and water velocities.	All estuaries except Tom Thumb Lagoon	WCC	\$5,000	\$10,000	\$143,007	90	-
108	Prepare a Visual Management Plan (VMP) to maintain significant views and vistas and require, through planning instruments, development control plans and design guidelines that all building and development applications conform to the VMP.	All estuaries except Tom Thumb Lagoon	WCC	\$10,000	\$1,000	\$23,801	199	-
19q	Provide signage to educate the community about the damage caused to dunes and Aboriginal heritage area through inappropriate activities and access, including the illegal removal of beach sand.	All estuaries, particularly Bellambi Lagoon	WCC, SRCMA	\$2,000	\$500	\$8,900	4	-
26	Reduce disturbance to coastal feeding, nesting and roosting areas of threatened shorebirds and migratory waders by implementing a protection zone around them (500m radius), and restricting beach-combing, fishing, dog-walking, horse-riding, 4WD vehicles and other disturbing activities in the immediate vicinity of the potential habitat. Initial focus to be on the Sooty Oystercatcher habitat at Stanwell Creek.	All estuaries, particularly Stanwell Creek	WCC, DECC	\$10,000	\$2,000	\$37,601	230	-
55	Regularly inspect and maintain stormwater treatment devices to ensure continued effectiveness.	All estuaries, particularly Tom Thumb Lagoon	WCC	\$0	\$5,000	\$69,004	83	In progress
34c	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	24	In progress
24c	Further investigate the importance of the potential habitat to the threatened species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	Bellambi Gully	WCC, DECC	\$5,000	\$0	\$5,000	52	-
15e	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Bellambi Gully	WCC, SRCMA	\$200,000	\$0	\$200,000	62	-
25c	Retain large stands of native and riparian vegetation, identify and protect any hollow-bearing trees and retain younger recruitment trees to replace older trees in the long-term, through implementation of DCPs and DA approval process.	Bellambi Gully	WCC, DECC	\$4,000	\$3,000	\$45,402	69	In progress
27a	Protect and manage potential habitat by creating buffer zones around it (with vegetation or through maintenance of high water levels) to minimise risk of human disturbance.	Bellambi Gully	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	80	-
19f	Erect interpretative signs to provide information to visitors and residents of the importance of the potential habitat for threatened birds (Australasian Bittern and Black Bittern).	Bellambi Gully	WCC, DECC, SRCMA	\$2,000	\$500	\$8,900	96	-
19j	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC.	Bellambi Gully	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	96	-
10d	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	114	-
19c	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc.	Bellambi Gully	WCC, SRCMA	\$2,000	\$500	\$8,900	125	-
22d	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing vegetation.	Bellambi Gully	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	133	-

Management Action No	Management Action	Estuary	Responsibility & Involvement	Capital Cost	Recurrent Cost	NPV	Rank	Notes
33c	Protect saltmarsh from disturbance through provision of signage and active management.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	142	-
71a	Investigate, verify and rectify potential erosion sites in upstream catchments.	Bellambi Gully	WCC, SRCMA	\$75,000	\$10,000	\$213,007	164	-
21d	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Bellambi Gully	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	168	-
20c	Protect potential riparian habitat for the Red Crowned Toadlet by minimising disturbance to the upper reaches of the creeks.	Bellambi Gully	WCC, DECC, SRCMA	\$7,500	\$500	\$14,400	176	-
17b	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Bellambi Gully	WCC, SRCMA	\$5,000	\$500	\$11,900	189	-
12a	Protect mangroves from human access/trampling and weed invasion.	Bellambi Gully	WCC, CVA, SRCMA	\$3,000	\$0	\$3,000	193	-
29c	Investigate and manage water quality and hydrological impacts on saltmarsh	Bellambi Gully	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	193	-
75	Monitor minor erosion in the vicinity of the footbridge to ensure it does not worsen and impact the footbridge in the future. Remediate erosion if considered necessary.	Bellambi Gully	WCC, SRCMA	\$0	\$750	\$10,351	203	-
31c	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
32c	Allow areas of saltmarsh to regenerate naturally where possible.	Bellambi Gully	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
23c	Investigate, and where possible implement, measures to control or eradicate the introduced Mosquito fish.	Bellambi Gully	WCC, DECC	\$5,000	\$0	\$5,000	223	-
28a	Monitor the presence, density, levels of activity, and potential impacts of feral animals, in particular foxes and cats, on threatened Bittern species	Bellambi Gully	WCC, DECC	\$5,000	\$0	\$5,000	228	-
87	Undertake stabilisation works on the northern bank of Bellambi Lagoon entrance to prevent/minimise further erosion and encroachment into an area of Aboriginal heritage.	Bellambi Lagoon	WCC, DECC, SRCMA	\$20,000	\$5,000	\$89,004	7	-
34d	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	11	In progress
88	Replace existing temporary fencing with permanent fencing to discourage human disturbance of particularly sensitive areas of the dunes and heritage area.	Bellambi Lagoon	WCC, DECC, SRCMA	\$15,000	\$5,000	\$84,004	12	-
38	Protect the Bangalay Sand Forest habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	Bellambi Lagoon	WCC, DECC, SRCMA	\$0	\$2,000	\$27,601	16	-
35b	Protect the swamp oak floodplain habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	Bellambi Lagoon	WCC, DECC	\$0	\$2,000	\$27,601	16	-
125	Investigate the undertakings agreed between SWC and WCC in the 1980's relating to the ongoing management of Bellambi Lagoon, and implement as appropriate.	Bellambi Lagoon	WCC	\$5,000	\$5,000	\$74,004	21	-
34g	Implement weed control programs to prevent and control infestation of Swamp Oak Floodplain EEC.	Bellambi Lagoon	WCC, CVA, DECC, SRCMA	\$10,000	\$1,000	\$23,801	24	In progress
19k	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC	Bellambi Lagoon	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	32	-
89	Erect interpretative signage at the beach reserve and adjacent to the Aboriginal heritage area.	Bellambi Lagoon	WCC, DECC	\$5,000	\$1,500	\$25,701	33	-
70d	Stabilise dunes near the estuary entrance in accordance with best management practice.	Bellambi Lagoon	WCC	\$50,000	\$10,000	\$188,007	34	-
19a	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc.	Bellambi Lagoon	WCC, SRCMA	\$2,000	\$500	\$8,900	39	-
18	Relocate or control access to existing informal paths to minimize impacts on the sensitive vegetation or habitats.	Bellambi Lagoon	WCC, SRCMA	\$20,000	\$5,000	\$89,004	40	-
10k	Relocate or control access to existing informal paths to minimize impacts on the sensitive vegetation or habitats.	Bellambi Lagoon	WCC, SRCMA	\$20,000	\$5,000	\$89,004	40	-
9a	Investigate and protect areas of valuable fish nursery habitat (seagrasses and mangroves), including an assessment of the implications of water quality and macroalgae on seagrasses.	Bellambi Lagoon	WCC, CVA, DPI	\$10,000	\$1,000	\$23,801	45	-
24d	Further investigate the importance of the potential habitat to the threatened species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	Bellambi Lagoon	WCC, DECC	\$5,000	\$0	\$5,000	52	-
25d	Retain large stands of native and riparian vegetation, identify and protect any hollow-bearing trees and retain younger recruitment trees to replace older trees in the long-term, through implementation of DCPs and DA approval process.	Bellambi Lagoon	WCC, DECC	\$4,000	\$3,000	\$45,402	69	In progress
86	Protect sites through the LEP following review of the heritage schedule	Bellambi Lagoon	WCC, DECC	\$5,000	\$500	\$11,900	73	In progress
27b	Protect and manage potential habitat by creating buffer zones around it (with vegetation or through maintenance of high water levels) to minimise risk of human disturbance.	Bellambi Lagoon	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	80	-
19g	Erect interpretative signs to provide information to visitors and residents of the importance of the potential habitat for threatened birds (Australasian Bittern and Black Bittern).	Bellambi Lagoon	WCC, DECC, SRCMA	\$2,000	\$500	\$8,900	96	-
36b	Undertake restoration of Swamp Oak Floodplain EEC including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users.	Bellambi Lagoon	WCC, CVA, DECC	\$15,000	\$1,500	\$35,701	104	-
36d	Undertake restoration of Bangalay Sand Forest EEC including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users.	Bellambi Lagoon	WCC, DECC, SRCMA	\$15,000	\$1,500	\$35,701	104	-
17c	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Bellambi Lagoon	WCC, SRCMA	\$5,000	\$500	\$11,900	113	-
10e	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	114	-
10h	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Swamp Oak Floodplain EEC.	Bellambi Lagoon	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	114	-
10j	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Bangalay Sand Forest EEC.	Bellambi Lagoon	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	114	-
19n	Erect interpretative signs to provide information to visitors and residents of the importance of the Swamp Oak Floodplain EEC.	Bellambi Lagoon	WCC, CVA, DECC, SRCMA	\$2,000	\$500	\$8,900	125	-
19p	Erect educational signs to provide information to visitors and residents of the importance of the Bangalay Sand Forest EEC.	Bellambi Lagoon	WCC, DECC, SRCMA	\$2,000	\$500	\$8,900	125	-
22e	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing vegetation	Bellambi Lagoon	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	133	-
33d	Protect saltmarsh from disturbance through provision of signage and active management.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	142	-
71b	Investigate, verify and rectify potential erosion sites in upstream catchments.	Bellambi Lagoon	WCC, SRCMA	\$75,000	\$10,000	\$213,007	164	-
21e	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Bellambi Lagoon	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	168	-
85	Formalise a beach access on the right bank and revegetate disturbed areas to reduce erosion.	Bellambi Lagoon	WCC, SRCMA	\$5,000	\$500	\$11,900	174	-
20d	Protect potential riparian habitat for the Red Crowned Toadlet by minimising disturbance to the upper reaches of the creeks.	Bellambi Lagoon	WCC, DECC, SRCMA	\$7,500	\$500	\$14,400	176	-
39	Promote public involvement in restoration and bush regeneration activities.	Bellambi Lagoon	WCC, DECC, SRCMA	\$1,500	\$500	\$8,400	185	-
37b	Promote public involvement in restoration and bush regeneration activities.	Bellambi Lagoon	WCC, CVA, DECC	\$1,500	\$500	\$8,400	185	-
29d	Investigate and manage water quality and hydrological impacts on saltmarsh	Bellambi Lagoon	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	193	-
12b	Protect mangroves from human access/trampling and weed invasion.	Bellambi Lagoon	WCC, CVA, SRCMA	\$4,000	\$0	\$4,000	198	-
31d	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
32d	Allow areas of saltmarsh to regenerate naturally where possible.	Bellambi Lagoon	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
23d	Investigate, and where possible implement, measures to control or eradicate the introduced Mosquito fish.	Bellambi Lagoon	WCC, DECC	\$5,000	\$0	\$5,000	223	-
28b	Monitor the presence, density, levels of activity, and potential impacts of feral animals, in particular foxes and cats, on threatened Bittern species	Bellambi Lagoon	WCC, DECC	\$5,000	\$0	\$5,000	228	-
16a	Investigate and implement actions to reduce feral species, if warranted.	Bellambi Lagoon	WCC	\$5,000	\$1,000	\$18,801	231	-

Management Action No	Management Action	Estuary	Responsibility & Involvement	Capital Cost	Recurrent Cost	NPV	Rank	Notes
113	Prepare entrance management policy in consultation with the community, the Estuary Management Committee, and Councillors.	Bellambi Lagoon	WCC	\$30,000	\$15,000	\$237,011	235	-
114	Where appropriate, implement entrance management policy, using the media to publicise entrance opening events.	Bellambi Lagoon	WCC	\$0	\$10,000	\$138,007	236	-
34b	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Collins Creek	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	24	In progress
15d	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Collins Creek	WCC, SRCMA	\$200,000	\$0	\$200,000	62	-
68b	Monitor impacts associated with leachate discharges from the old landfill at Collins Creek.	Collins Creek	WCC	\$25,000	\$10,000	\$163,007	93	-
19i	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC	Collins Creek	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	96	-
10c	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Collins Creek	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	114	-
19d	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc.	Collins Creek	WCC, SRCMA	\$2,000	\$500	\$8,900	125	-
22c	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing vegetation.	Collins Creek	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	133	-
33b	Protect saltmarsh from disturbance through provision of signage and active management.	Collins Creek	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	142	-
71g	Investigate, verify and rectify potential erosion sites in upstream catchments.	Collins Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	150	-
21c	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Collins Creek	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	168	-
17e	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Collins Creek	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	189	-
29b	Investigate and manage water quality and hydrological impacts on saltmarsh	Collins Creek	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	193	-
31b	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Collins Creek	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
32b	Allow areas of saltmarsh to regenerate naturally where possible.	Collins Creek	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
23b	Investigate, and where possible implement, measures to control or eradicate the introduced Mosquito fish.	Collins Creek	WCC, DECC	\$5,000	\$0	\$5,000	223	-
14b	Establish and maintain well-vegetated riparian zones using appropriate local native riparian vegetation in accordance with floodplain management objectives and Sydney Water infrastructure.	Flanagans Creek	WCC, SRCMA	\$20,000	\$2,000	\$47,601	35	-
15a	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Flanagans Creek	WCC, SRCMA	\$200,000	\$0	\$200,000	62	-
70a	Stabilise dunes near the estuary entrance in accordance with best management practice.	Flanagans Creek	WCC	\$15,000	\$3,000	\$56,402	110	-
23a	Investigate, and where possible implement, measures to control or eradicate the introduced Mosquito fish.	Flanagans Creek	WCC, DECC	\$5,000	\$0	\$5,000	223	-
71d	Investigate, verify and rectify potential erosion sites in upstream catchments.	Flanagans Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	150	-
34a	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	24	In progress
61a	Require all residents to connect to the Stanwell Park Sewerage Scheme.	Hargraves Creek	WCC	\$0	\$5,000	\$69,004	42	-
24a	Further investigate the importance of the potential habitat to the threatened species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	Hargraves Creek	WCC, DECC	\$5,000	\$0	\$5,000	52	-
25a	Retain large stands of native and riparian vegetation, identify and protect any hollow-bearing trees and retain younger recruitment trees to replace older trees in the long-term, through implementation of DCPs and DA approval process.	Hargraves Creek	WCC, DECC	\$4,000	\$3,000	\$45,402	69	In progress
56a	Investigate reported water pollution events to determine and rectify the source. Investigate and rectify source of pollution of a small ephemeral tributary of Hargraves Creek, which has large volumes of bubbles and a grey colouration during rainfall periods. Investigate the potential impact of the impoundment of Stony Creek on water quality, hydrology and ecology.	Hargraves Creek	WCC	\$2,500	\$0	\$2,500	91	-
19h	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC	Hargraves Creek	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	96	-
78	Formalise the beach access and revegetate at area of erosion H3 (refer Figures F1-F10 in the EPS report).	Hargraves Creek	WCC, SRCMA	\$7,500	\$500	\$14,400	107	-
70c	Stabilise dunes near the estuary entrance in accordance with best management practice.	Hargraves Creek	WCC	\$15,000	\$3,000	\$56,402	110	-
10b	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	114	-
19b	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc.	Hargraves Creek	WCC, SRCMA	\$2,000	\$500	\$8,900	125	-
22a	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing vegetation.	Hargraves Creek	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	133	-
20a	Protect potential riparian habitat for the Red Crowned Toadlet by minimising disturbance to the upper reaches of the creeks.	Hargraves Creek	WCC, DECC, SRCMA	\$7,500	\$500	\$14,400	140	-
33a	Protect saltmarsh from disturbance through provision of signage and active management.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$5,000	\$500	\$11,900	142	-
76	Fence area of bank erosion H1 (refer Figures F1-F10 in the EPS report) and revegetate the understorey vegetation to reduce the extent and rate of erosion.	Hargraves Creek	WCC, SRCMA	\$15,000	\$3,000	\$56,402	148	-
77	Establish a fenced revegetated riparian zone at area of bank erosion H2 (refer Figures F1-F10 in the EPS report) to reduce the extent and rate of erosion.	Hargraves Creek	WCC, SRCMA	\$15,000	\$3,000	\$56,402	148	-
71c	Investigate, verify and rectify potential erosion sites in upstream catchments.	Hargraves Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	150	-
21a	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Hargraves Creek	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	168	-
17d	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Hargraves Creek	WCC, SRCMA	\$5,000	\$500	\$11,900	189	-
29a	Investigate and manage water quality and hydrological impacts on saltmarsh	Hargraves Creek	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	193	-
31a	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
32a	Allow areas of saltmarsh to regenerate naturally where possible.	Hargraves Creek	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
7b	Investigate the potential impacts on estuarine ecology and water quality of the small weir across Slacky Creek (located immediately upstream of the road), and modify/remove this potential barrier to fish passage as appropriate.	Slacky Creek	WCC, CVA, DPI	\$50,000	\$0	\$50,000	68	-
15b	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Slacky Creek	WCC, SRCMA	\$200,000	\$0	\$200,000	62	-
81	Provide rock toe protection at area of bank erosion S1 (refer Figures F1-F10 in the EPS report), re-shape the upper bank, and revegetate.	Slacky Creek	WCC, SRCMA	\$40,000	\$5,000	\$109,004	88	-
82	Provide rock toe protection at area of bank erosion S2 (refer Figures F1-F10 in the EPS report), re-shape, to minimize erosion. Revegetate to improve riparian vegetation corridor and increase bank stability.	Slacky Creek	WCC, SRCMA	\$40,000	\$5,000	\$109,004	88	-
71e	Investigate, verify and rectify potential erosion sites in upstream catchments.	Slacky Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	150	-
35a	Protect the swamp oak floodplain habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	Stanwell Creek	WCC, DECC	\$0	\$2,000	\$27,601	16	-
34f	Implement weed control programs to prevent and control infestation of Swamp Oak Floodplain EEC.	Stanwell Creek	WCC, CVA, DECC, SRCMA	\$10,000	\$1,000	\$23,801	24	In progress
61b	Require all residents to connect to the Stanwell Park Sewerage Scheme.	Stanwell Creek	WCC	\$0	\$5,000	\$69,004	42	-
24b	Further investigate the importance of the potential habitat to the threatened species' potential presence in the area, including an assessment of the linkages the site provides for the species between ecological resources across the broader landscape.	Stanwell Creek	WCC, DECC	\$5,000	\$0	\$5,000	52	-

Management Action No	Management Action	Estuary	Responsibility & Involvement	Capital Cost	Recurrent Cost	NPV	Rank	Notes
25b	Retain large stands of native and riparian vegetation, identify and protect any hollow-bearing trees and retain younger recruitment trees to replace older trees in the long-term, through implementation of DCPs and DA approval process.	Stanwell Creek	WCC, DECC	\$4,000	\$3,000	\$45,402	69	In progress
74	Investigate and if necessary de-silt Stanwell Creek immediately downstream of the causeway to restore its original profile and depth (following finalisation of repairs/reconstruction of Lower Coast Road).	Stanwell Creek	WCC	\$25,000	\$5,000	\$94,004	87	-
73	Investigate alternative methods to repair Lower Beach Road, Stanwell Park, to minimise erosion of material and deposition in Stanwell Creek. Alternatively, re-design and resurface the road to restore integrity and stability.	Stanwell Creek	WCC	\$150,000	\$20,000	\$426,015	95	-
36a	Undertake restoration of Swamp Oak Floodplain EEC including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users.	Stanwell Creek	WCC, CVA, DECC	\$15,000	\$1,500	\$35,701	104	-
10g	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Swamp Oak Floodplain EEC.	Stanwell Creek	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	114	-
19e	Erect interpretative signage to educate the community about sensitive species, habitats & vegetation, cultural heritage values, water quality, consequences of artificial entrance openings, etc.	Stanwell Creek	WCC, SRCMA	\$2,000	\$500	\$8,900	125	-
19m	Erect interpretative signs to provide information to visitors and residents of the importance of the Swamp Oak Floodplain EEC.	Stanwell Creek	WCC, CVA, DECC, SRCMA	\$2,000	\$500	\$8,900	125	-
22b	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing vegetation.	Stanwell Creek	WCC, CVA, DECC, SRCMA	\$23,000	\$5,000	\$92,004	133	-
20b	Protect potential riparian habitat for the Red Crowned Toadlet by minimising disturbance to the upper reaches of the creeks.	Stanwell Creek	WCC, DECC, SRCMA	\$7,500	\$500	\$14,400	140	-
80	Extend the existing rock toe protection downstream to area of bank erosion SW2 (refer Figures F1-F10 in the EPS report). Provide revegetation and fencing to control access along the downstream section.	Stanwell Creek	WCC, SRCMA	\$40,000	\$5,000	\$109,004	158	-
79	Provide rock toe protection at area of bank erosion SW1 (refer Figures F1-F10 in the EPS report), and revegetate upper bank with understorey and shrub species. Extend downstream through the minimally active zone.	Stanwell Creek	WCC, SRCMA	\$65,000	\$10,000	\$203,007	162	-
21b	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Stanwell Creek	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	168	-
37a	Promote public involvement in restoration and bush regeneration activities.	Stanwell Creek	WCC, CVA, DECC	\$1,500	\$500	\$8,400	185	-
17a	Formalise existing beach access points to minimise impacts to endangered ecological communities and the habitats of protected species, through provision of boardwalks and fencing.	Stanwell Creek	WCC	\$5,000	\$500	\$11,900	189	-
14a	Establish and maintain well-vegetated riparian zones using appropriate local native riparian vegetation in accordance with floodplain management objectives and Sydney Water infrastructure.	Stoney Creek	WCC, SRCMA	\$10,000	\$1,000	\$23,801	15	-
61c	Require all residents to connect to the Stanwell Park Sewerage Scheme. Investigate reported water pollution events to determine and rectify the source.	Stoney Creek	WCC	\$0	\$5,000	\$69,004	42	-
56b	Investigate and rectify source of pollution of a small ephemeral tributary of Hargraves Creek, which has large volumes of bubbles and a grey colouration during rainfall periods. Investigate the potential impact of the impoundment of Stoney Creek on water quality, hydrology and ecology.	Stoney Creek	WCC	\$2,500	\$0	\$71,504	167	-
71h	Investigate, verify and rectify potential erosion sites in upstream catchments. Protect the swamp oak floodplain habitat by minimising further clearing of the community. This requires recognition of the values of all remnants in the land use planning process, particularly development consents, rezonings and regional planning.	Stoney Creek	WCC, SRCMA	\$25,000	\$3,000	\$66,402	150	-
35c	Implement weed control programs to prevent and control infestation of Coastal Saltmarsh EEC.	Tom Thumb Lagoon	WCC, DECC	\$0	\$2,000	\$27,601	16	-
34e	Implement weed control programs to prevent and control infestation of Swamp Oak Floodplain EEC.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$10,000	\$1,000	\$23,801	24	In progress
34h	Investigate and protect areas of valuable fish nursery habitat (seagrasses and mangroves), including an assessment of the implications of water quality and macroalgae on seagrasses.	Tom Thumb Lagoon	WCC, CVA, DECC, SRCMA	\$10,000	\$1,000	\$23,801	24	In progress
9b	Investigate the potential impacts on estuarine ecology and water quality of the proposed removal of the causeway across Garangaty waterway, and modify/remove this potential barrier to fish passage as appropriate.	Tom Thumb Lagoon	WCC, CVA, DPI	\$10,000	\$1,000	\$23,801	45	-
7a	Investigate and manage water quality and hydrological impacts on saltmarsh	Tom Thumb Lagoon	WCC, CVA, DPI	\$100,000	\$0	\$100,000	58	-
29e	Investigate and manage competition between mangroves and saltmarsh in consultation with DPI	Tom Thumb Lagoon	WCC, DECC, SRCMA	\$3,000	\$0	\$3,000	59	In progress
30	Monitor impacts associated with leachate discharges from the old landfill at TTL.	Tom Thumb Lagoon	WCC, CVA, DPI, DECC	\$1,500	\$1,500	\$22,201	92	In progress
68a	Erect interpretative signs to provide information to visitors and residents of the importance of the Coastal Saltmarsh EEC.	Tom Thumb Lagoon	WCC	\$25,000	\$10,000	\$163,007	93	In progress
19i	Undertake restoration of Swamp Oak Floodplain EEC including bush regeneration and revegetation in accordance with floodplain management objectives, whilst providing access to authorised users.	Tom Thumb Lagoon	WCC, DPI, SRCMA	\$2,000	\$500	\$8,900	96	-
36c	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Coastal Saltmarsh EEC.	Tom Thumb Lagoon	WCC, CVA, DECC	\$20,000	\$2,500	\$54,502	109	-
10f	Minimise human disturbance by installing gates, fencing and bollards to prevent vehicular access to areas of Swamp Oak Floodplain EEC.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$7,500	\$1,500	\$28,201	114	-
10i	Protect mangroves from human access/trampling and weed invasion.	Tom Thumb Lagoon	WCC, DECC, SRCMA	\$7,500	\$1,500	\$28,201	114	-
12c	Erect interpretative signs to provide information to visitors and residents of the importance of the Swamp Oak Floodplain EEC.	Tom Thumb Lagoon	WCC, CVA, SRCMA	\$1,000	\$0	\$1,000	123	-
19o	Enhance frog habitat to improve reproductive success and recruitment by creating additional freshwater habitats, revegetating appropriately and controlling invasive weeds to maintain existing vegetation.	Tom Thumb Lagoon	WCC, CVA, DECC, SRCMA	\$2,000	\$500	\$8,900	125	-
22f	Protect saltmarsh from disturbance through provision of signage and active management.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$7,500	\$500	\$14,400	147	-
33e	Investigate options to mitigate water quality impacts from the sewer overflow upstream of Tom Thumb Lagoon and implement when possible.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$10,000	\$5,000	\$79,004	156	In progress
67	Minimise disturbance to, and restore, potential GGBF riparian habitat by fencing and revegetating to create buffer zones.	Tom Thumb Lagoon	WCC, CVA, DECC, SRCMA	\$7,500	\$1,500	\$28,201	168	-
37c	Promote public involvement in restoration and bush regeneration activities.	Tom Thumb Lagoon	WCC, CVA, DECC	\$1,500	\$500	\$8,400	185	-
69	Undertake a desktop assessment of existing water quality discharge data to investigate the potential for water quality improvement in TTL as a result of the closure of the Tin Mill.	Tom Thumb Lagoon	WCC	\$2,500	\$0	\$2,500	209	-
31e	Maintain buffer zones of terrestrial vegetation adjacent to saltmarsh to allow for expansion of saltmarsh and to minimise nutrient flow.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
32e	Allow areas of saltmarsh to regenerate naturally where possible.	Tom Thumb Lagoon	WCC, CVA, DPI, SRCMA	\$0	\$1,000	\$13,801	213	-
16b	Investigate and implement actions to reduce feral species, if warranted.	Tom Thumb Lagoon	WCC	\$5,000	\$1,000	\$18,801	231	-
123	Identify, maintain, support, improve and acknowledge the existing partnerships with Friends of TTL, CVA, PKPC, Port Kembla Coal Terminal, Bluescope Steel, CMA, DECC, DPI, SWC and other Divisions of WCC, and the success of their combined efforts in improving the management of TTL.	TTL	TTL Stakeholders	\$500	\$500	\$7,400	9	-
124	Maintain and improve the existing partnership approach to facilitate the improved management, clean-up and notification of sewage overflow events affecting TTL, including consideration of installing a gross pollutant trap, and maintenance of SWC infrastructure throughout TTL.	TTL	CVA, FoTTL, SWC	\$500	\$500	\$7,400	9	-
14c	Establish and maintain well-vegetated riparian zones using appropriate local native riparian vegetation in accordance with floodplain management objectives and Sydney Water infrastructure.	Whartons Creek	WCC, SRCMA	\$25,000	\$2,500	\$59,502	38	-
15c	Investigate bank regrading works to provide a wider and less steep riparian corridor with improved habitats in accordance with floodplain management objectives, whilst providing access to authorised users.	Whartons Creek	WCC, SRCMA	\$200,000	\$0	\$200,000	62	-
70b	Stabilise dunes near the estuary entrance in accordance with best management practice.	Whartons Creek	WCC	\$15,000	\$3,000	\$56,402	110	-
83	Supplement the erosion protection (gabion baskets) provided near the entrance to the estuary with revegetation.	Whartons Creek	WCC, SRCMA	\$10,000	\$2,500	\$44,502	146	-
71f	Investigate, verify and rectify potential erosion sites in upstream catchments.	Whartons Creek	WCC, SRCMA	\$40,000	\$5,000	\$109,004	159	-
84	Restrict access to, and revegetate, the left bank between the entrance to Bulli Beach Holiday Park and the footbridge.	Whartons Creek	WCC, SRCMA	\$15,000	\$2,000	\$42,601	183	-



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