Appendix A

Site Photolog

Photo 1: Hylton Moore Park, showing recreation areas and car park facilities. (W01)

Photo 2: Boat ramp and jetty facilities at Erina Creek, looking upstream (north east). (W41, W107)

Photo 3: Gosford foreshore, looking east. (R14)

Photo 4: Stormwater traps along Gosford foreshore. (W27)

Photo 5: Boat ramp next to Iguana Joe's, Gosford. (P48, R31)

Photo 6: Gosford Public Wharf. (P48, R31)

Photo 7: Looking north along Ettalong Beach. The Ettalong Mantra Hotel and recreational users of Ettalong Beach are evident in the background. (W28, W97)

Photo 8: Ferry from Palm Beach to Wagstaffe/Ettalong. (R23, R34)

Photo 9: Boat ramp at Ettalong beach (mid tide). (P48, R31)

Photo 10: Boulders along Ettalong Beach (looking north). (W29)

Photo 11: Tree vandalism sign along the Ettalong foreshore. (C05)

Photo 12: Looking south along Ettalong foreshore – seawall with adjacent recreational area. Lack of beach

	access points along this stretch. (W112)
	
Photo 13: Informal vessel ramp along Ettalong foreshore. (P48, R31, C14)	**Photo 14:** Informal boat ramp amidst numerous private jetties, at Woy Woy Bay. (P48, R31, C14)
	
Photo 15: Looking east towards Correa Bay, just downstream of Woy Woy Creek. (W04, W21)	**Photo 16:** Amenities located at Correa Bay Reserve. (W78)
	
Photo 17: Public baths along the Woy Woy foreshore - visually poor water quality. (W108)	**Photo 18:** Woy Woy jetty where ferry to Davistown, Saratoga and Empire Bay departs. (P48, R31)

Photo 19: Jetty at Lions Park (at end of North Berge Rd, Woy Woy) showing use of fishing nets. (P48, R31)

Photo 20: Fish cleaning facilities at Lions Park. (P48, R31)

Photo 21: Lions Park boat ramp. (P48, W80, R31)

Photo 22: Informal boat ramp at Koolewong Foreshore Reserve. (C14)

Photo 23: Erosion and rock armour along the Koolewong Foreshore. (W69)

Photo 24: Informal dinghy storage along Masons Parade, Point Frederick (looking south). (W77, W86)

Photo 25: Recreational use of beach north of Gosford Sailing Club. (W106)

Photo 26: Point Frederick seawall looking north. (W69)

Photo 27: Rocky point foreshore. (W104)

Photo 28: Yattalunga tidal pool showing depth at high tide. (W103).

Photo 29: Looking north along Mundoora Avenue, Yattalunga. (W38,W63,W10)

Photo 30: Centennial Avenue boat ramp at high tide. (W50, P48, R31)

Photo 31: Looking south along foreshore near Lintern Street, Davistown. (W48)

Photo 32: Looking east along Illoura Reserve foreshore. (W56)

Photo 33: Looking south from Carrak Road towards Kincumber Reserve. (C06)

Photo 34: RSL Creek culvert into Hardys Bay. (W23)

Photo 35: Foreshore erosion adjacent to Araluen Drive, Hardys Bay. (W39)

Photo 36: Empire Bay Wetland. (W71)

Photo 37: Oyster leases in Lintern Channel, near Davistown. (W100)

Photo 38: St Huberts Island, looking west. (W35)

Photo 39: Informal sea wall (R13)

Photo 40: Sedimentation in Hardys Bay. (W24, W120)

Photo 41: The Entrance to Brisbane Water, looking south west. (W18)

Photo 42: Brisbane Water Drive causeway adjacent to railway line (looking west). (W11, W12, R35)

Appendix B

Community Consultation Materials

Appendix B1

Stakeholder Consultation

Our Ref LJ2717/L1528:TJM/ERM

Contact Emma Maratea

Cardno Lawson Treloar Pty Ltd
ABN 55 001 882 873

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Gordon New South Wales
2072 Australia
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Mackay
Rockhampton
Hervey Bay
Sunshine Coast
Toowoomba
Gold Coast
Gosford
Baulkham Hills
Wollongong
Busselton

Papua New Guinea
Indonesia
Vietnam
China
Kenya
United Arab Emirates
United Kingdom
United States

[Contact Name]
[Department]
[Agency]
[Address]
[Address]

4 June 2008

Dear *[Name]*,

RE: BRISBANE WATER ESTUARY MANAGEMENT STUDY AND PLAN

We are writing to inform you that Cardno Lawson Treloar has been engaged by Gosford Council and the Department of Environment and Climate Change (DECC) to undertake the Brisbane Water Estuary Management Study and Plan.

The study area is indicated in the attached figure.

The aim of the Management Study and Plan is to provide a balanced and long term management framework for the ecological sustainable use of the estuary and its catchment. The Management Study will set the context for the Management Plan by providing details on:

- The consultation process,
- The outcome of the estuary processes study,
- Estuary values, uses and significance,
- Regulatory and management context,
- Management issues and objectives, and
- Management Options (to include an explicit options assessment).

After the Management Study has been prepared, the preferred options will be developed into a series of management actions to be adopted as part of the Management Plan. The Management Plan will also detail an implementation strategy and monitoring and evaluation plan.

The Estuary Management Study and Plan represents the final stage in the Estuary Management Process for Brisbane Water, as outlined in the Estuary Management Manual (NSW Government, 1992). The Data Compilation and Estuary Processes Studies have already been completed, the latter study having been undertaken by Cardno Lawson Treloar in association with a range of sub-consultants.

We would be grateful for your input into the development of the Management Study and Plan, particularly with respect to identification of any management issues relating to Brisbane Water. Identification of management issues is a critical stage in the development of the Management Plan. The final list of management issues will be used to delineate the management objectives for

Brisbane Water. The list of management issues will also provide the framework upon which a comprehensive list of management options, which will then be translated into management actions for adoption in the Management Plan.

In addition, we would also appreciate your assistance in identifying (and providing, where possible) any additional studies have been undertaken since the completion of the Estuary Processes Study.

Please do not hesitate to contact either myself or Tanja Mackenzie, at tanja.mackenzie@cardno.com.au, should you require any further information.

Yours faithfully

Emma Maratea
for **Cardno Lawson Treloar**

Figure 1: Study Area

NSW **National Parks and Wildlife Service**

Our reference : DOC08/27507
In response to : DOC08/26647
Your reference : LJ2717/L1528h:TJM/ERM

Ms Emma Maratea
Cardno Lawson Treloar
Level 2, 910 pacific Highway
Gordon
NSW, 2072

Brisbane Water Estuary Management Study and Plan

Dear Emma,

Thank you for your letter advising of the proposed study and estuary management plan for Brisbane Water.

The National Parks and Wildlife Service (NPWS) as part of the Department of Environment and Climate Change (DECC) manages a number of areas that are directly adjacent to Brisbane Water estuary, including Bouddi and Brisbane Water National Parks and Cockle Bay, Rileys Island, Pelican Island and Saratoga Island Nature Reserves.

Plans of Management (PoM) exist for these reserves in which the major issues, management outcomes and strategies are identified.

In the Cockle Bay, Rileys Island, Pelican Island and Saratoga Island Nature Reserves PoM (draft) there are a few management issues which directly involve Brisbane Water estuary processes, which should be included in the management study and plan. These issues include the:

- Survey of the landward mangrove encroachment of the saltmarsh communities,
- Examination of feasibility and methods to manage mangrove encroachment,
- Rehabilitation of Saltmarsh - Endangered Ecological Communities (EEC's),
- Protection of habitat for migratory birds, and
- Inclusion of the surrounding Intertidal Zones (ITZ) within the nature reserve boundaries.

These strategies have been allocated a high to medium management priority within the PoM.

Thank you for the opportunity to comment and if you require further information please contact Ranger Vicki Elliott, ph: 43204202 or Ranger Liz Phelps, ph; 43204223.

Yours sincerely

Richard Colbourne
A/Area Manager Gosford
Central Coast Hunter Range Region
Date: 19/6/08

PO Box 1477, Gosford NSW 2250
Suites 36-38, 207 Albany St North, Gosford NSW
Tel: (02) 4320 4200 Fax: (02) 4320 4299
ABN 30 841 387 271
www.environment.nsw.gov.au

Cnr New England Highway & Banks Street
(PO Box 6) East Maitland NSW 2323
Contact Officer: Martin Dawson
Phone:(02) 49 379 346
Fax: 49 348 417
E-mail: martin.dawson@lands.nsw.gov.au
www.lands.nsw.gov.au

Cardno Lawson Treloar
Level 2, 910 Pacific Highway
GORDON NSW 2072

Date:
Your Ref: LJ2717/L1528e:TJM/ERM
Our Ref: MD07/4965

Attention: Emma Maratea

Dear Madam,

BRISBANE WATER ESTUARY MANAGEMENT STUDY AND PLAN

I refer to your letter seeking the Department of Lands input into the development of the subject plans and thank you for the opportunity to comment.

The Department of Lands is a major land holder within the estuary and catchment. Hence the outcomes of these reports could directly effect Lands' operations across a broad range of activities. To get a full appreciation of the Department's position it would be appropriate to schedule a meeting in due course between Lands, Council and yourselves.

The bed of Brisbane Water is almost entirely crown land and any use or activity in this area generally requires some form of consideration or authorisation by the Department. As such, relevant issues requiring discussion include:

1) The waterway is currently unzoned, however the Department agrees that this should be rectified under Council's current LEP review. It is crucial to incorporate Lands' needs in this process.
2) Consolidation of the various planning instruments for waterway development and use, based on factors such as; regulation by other agencies/legislation, ecological values, water depth, adjoining land zonings, climate change impacts, zoning of waterways, DCP's, maintenance dredging requirements and maintenance of facilities such as marinas and jetties. Ideally, a "red, green and amber light" type system of planning zones would ensue.

   The development of a comprehensive policy or DCP for waterfront structures, having regard for the impacts of structures, their benefits and uses, based on the latest estuary processes study. Issues for consideration might include: suitability or otherwise for facilities fronting public land and reserves; restrictions/guidelines on the design, proliferation and length of structures, and dealing with unauthorised and abandoned structures.
3) The importance of commercial activities and occupations on the waterway, and their contribution to revenue and hence environmental and social values must be recognised and facilitated by any planning mechanisms, where in the public interest.

4) The impact of any proposed changes on existing operations (leases and licences) authorised by the Department. Notably, Lands has issued almost 1000 licences for jetties in Brisbane Water and many hundreds of other tenures relevant to the study. Some of these are for significant commercial/social uses such as the area's marinas.

5) Requirements for both small craft storage and deep-draft vessel mooring and management need to be considered and facilitated.

6) The role of foreshore crown reserves and that of adjoining waterway structures such as public jetties. The latter would preferably be "owned" and managed by Council.

7) The planning process for the Gosford city centre and foreshores will be important to this process.

8) Consideration of reclamation restrictions and needs, on commercial, social and environmental grounds. Any such proposals should be dealt with on their merits.

9) Drainage requirements and management of catchment values; including potential development of artificial wetlands as nutrient traps or the placement of gross pollutant traps on drainage courses.

I look forward to discussing the Crown's role in the area further. Meantime, if you have any further inquiries regarding this matter please contact either Martin Dawson at our Maitland Office on 49379346 or myself on 0413 745 496.

Yours sincerely

Anthony Signor
Program Manager, Land Management
Crown Lands Division
Central Coast / Hunter Region

NSW GOVERNMENT
Department of Planning

Contact: Ben Holmes
Phone: 02 4348 5003
Fax: 02 4323 6573
Email: ben.holmes@planning.nsw.gov.au

Our ref: CC08/94
Your ref:
File: C08/00005

To	ERM
Date	18-07-08
File	
Circulation	

Ms Emma Maratea
Cardno Lawson Treloar Pty Ltd
Level 2
910 Pacific Highway
GORDON NSW 2072

Dear Ms Maratea

Brisbane Water Estuary Management Study & Plan

I refer to your letter dated 4 June 2008 whereby you seek the Department's advice regarding estuary management issues that should be addressed as part of the preparation of the Brisbane Water Estuary Management Plan.

I wish to advise that the Estuary Management Plan should give consideration to the following issues:

- sustainable growth of oyster aquaculture development and other related matters as detailed in *State Environmental Planning Policy 62 – Sustainable Aquaculture*;
- expansion of marina/ boating facilities and increased boating/ fishing activities on Brisbane Water;
- stormwater impacts associated with increased urban development within the Brisbane Water catchment, particularly in areas such as the Peninsula, Gosford and Erina which will experience growth per the *Central Coast Regional Strategy*;
- preservation and protection of coastal wetlands; and
- impacts associated with climate change/ sea level rise.

Should you have any queries or require further information, please contact me on 4348 5003 or by email ben.holmes@planning.nsw.gov.au.

Yours sincerely

16/7/08

Ben Holmes
Environmental Planner
Hunter & Central Coast

NSW GOVERNMENT
Department of Planning

Contact: Cathy Colville
Telephone: 02 9873 8588
Catherine.colville@planning.nsw.gov.au
File: S90/03597/009
Our Ref: HRL50607
Your Ref: LJ2717/L1528k:TJM/ERM

To	ERM
Date	29-7-08
File	
Circulation	

The Director
Cardno Lawson Treloar
Level 2, 910 Pacific Highway
GORDON NSW 2072

Attention: Emma Maratea
Tanja Mackenzie

Dear Sir/Madam

Re: Brisbane Water Estuary Management Study & Plan

Thank you for notifying the Department of Planning's Heritage Branch that Gosford Council has engaged your firm to undertake the Brisbane Water Estuary Management Study and Plan and for requesting information for the preparation of the Study.

It is understood that the aim of the Management Study and Plan is to provide a balanced and long term management framework for the ecological sustainable use of the estuary and its catchment. It would appear from our records that no natural heritage items of State heritage significance (listed on the State Heritage Register) exist within the Study area. However, the Heritage Council maintains the State Heritage Inventory which lists some items protected under the Heritage Act, 1977 and other statutory instruments. This register can be accessed through the Heritage Branch home page on the internet (http:/www.heritage.nsw.gov.au). It should be noted that the legal standing of items listed on the State Heritage Register can also be provided by applying for a section 167 Certificate through the Heritage Branch home page.

In addition, lists maintained under the Australian Government's Environment Protection and Biodiversity Conservation Act 1999, the National Trust and the local council should be consulted in order to identify any existing items of heritage significance in the Study area. Please be aware, however, that these lists are constantly evolving and that items with potential heritage significance may not yet be listed.

Where the Management Study and Plan may result in any impacts on heritage items (if any are found to be within the Study area), a statement of significance and an assessment of the impact of the proposal on the heritage significance of these items should be undertaken. Any policies/measures to conserve their heritage significance should be identified. This assessment should be undertaken in accordance with the guidelines in the NSW Heritage Manual. The field survey and assessment should be undertaken by a qualified practitioner/consultant with historic sites experience.

Where the Management Study and Plan may have any impacts on Aboriginal heritage, adequate community consultation should take place regarding the assessment of significance, likely impacts and management/mitigation measures. For guidelines regarding the assessment of Aboriginal sites, please contact the National Parks and Wildlife Division of the Department of Environment and Conservation on (02) 9585 6444.

I trust these comments are of assistance. If you require any additional information please contact Cathy Colville on (02) 9873 8588.

Yours faithfully

25/7/2008

Rajeev Maini
Acting Manager
Conservation Team
Heritage Branch
Department of Planning

Appendix B2

Initial Press Release and Newsletter

MEDIA RELEASE

25 March 2009

COUNCIL TO UNDERTAKE A MANAGEMENT PLAN AND STUDY FOR BRISBANE WATER ESTUARY

Gosford City Council has announced today a major project to undertake a Management Study and Management Plan of the Brisbane Water Estuary. Council has engaged the services of Cardno Lawson Treloar to undertake the study and plan which will begin in March 2009. This follows on from the successful completion of the Brisbane Water Estuary Process Study in February 2008 and adoption of the report in early 2009.

The estuary management process is part of the NSW State Government's Rivers and Estuaries Policy. This study is being prepared under the guidance of the Coastal and Estuary Management Committee (CEMC) which is convened by Gosford City Council.

The study area encompasses the entire estuary and its drainage catchment with linkages to Broken Bay and the Tasman Sea. The major estuarine tributaries are:

- Ettalong Creek;
- Woy Woy Creek;
- Coorumbine Creek;
- Upper and Lower Narara Creek;
- Upper and Lower Erina Creek; and
- Kincumber Creek.

The project is jointly funded under the Estuary Management Program between Department of Environment and Climate Change and Gosford City Council.

Gosford City Council's Mayor Chris Holstein said: "The study and plan will provide strategic guidance for future management and decision making regarding the Brisbane Water Estuary. I would encourage all of the community who value the area to participate in the upcoming workshop on 4 April 2009 at the Erina Centre"

In developing the study and plan, Council will ensure that the following objectives are also achieved:

- Improve the awareness and understanding of the estuarine system by the local community;
- Increase commitment by stakeholders to implement the plan; and
- Foster a spirit of cooperation between stakeholders managing the Brisbane Water Estuary.

The Management Plan is expected to be completed by early 2010.

ENDS

For further information contact:
Ann Stewart
Senior Environment Planning Officer
Gosford City Council
(*Telephone:* 02 4325 8885 or *email:* ann.stewart@gosford.nsw.gov.au).
RSVP for workshop to: brisbanewater@cardno.com.au

Brisbane Water Estuary Management Study and Plan

Community Newsletter

March 2009

Background

Gosford City Council and the Department of Environment and Climate Change have begun work on the Brisbane Water Estuary Management Study and Plan. This Management Study and Plan is being conducted under the NSW Government Estuary Management Process, which is part of the State Government's Rivers and Estuaries Policy.

As part of this process, Gosford City Council has engaged **Cardno Lawson Treloar** Pty Ltd to prepare the Estuary Management Study and Plan. The purpose of this study is to identify and recommend appropriate actions to manage the environmental social and commercial aspects of Brisbane Water Estuary.

The Study Area

The study area encompasses the entire estuary and its drainage catchment, with linkages to Broken Bay and the Tasman Sea (see **Figure 1**). The study area includes the tidal waterway, foreshore and adjacent land of Brisbane Water.

Figure 1: Study Area

The major estuarine tributaries included in the study area are:

- Ettalong Creek,
- Woy Woy Creek,
- Coorumbine Creek,
- Upper and Lower Narara Creek,
- Upper and Lower Erina Creek, and
- Kincumber Creek.

The Estuary Processes Study

Cardno Lawson Treloar recently completed the Brisbane Water Estuary Processes Study, which investigated the complex interactions occurring in the estuary, involving:

- Catchment Processes (land use, stormwater runoff, flooding);
- Hydrodynamic Processes (water movement, waves);
- Geomorphological Processes (erosion, siltation, shoal movements);
- Water Quality Processes;
- Ecological Processes;
- Cultural Heritage Values; and
- Recreational Usage.

Using this information, Cardno Lawson Treloar will be proceeding with the next stage of the Estuary Management Process (the Management Study and Plan) to identify appropriate management actions.

The Estuary Management Study and Plan

The Brisbane Water Estuary Management Study and Plan represents the final stage in the Estuary Management Process. It seeks to establish a strategic framework for the future management of Brisbane Water.

The Management Study will identify relevant management issues and objectives for Brisbane Water. A range of management options will then be identified to address these issues. Based on consultation with the community, stakeholders and Gosford Council, recommendations will be made as to the preferred management options. These preferred options will be translated into management actions for implementation and will form the basis of the Management Plan.



The Estuary Management Study and Plan (cont.)

For example, Council is aware that navigation on the estuary waterways has become increasingly difficult at some locations and is working towards developing a Plan for managing potential dredging works within the Brisbane Water estuary as part of the Management Study and Plan.

In 2007 *Coastal Lake Assessment and Management* (CLAM) decision support computer models were developed to investigate two dredging scenarios in the Gosford and Entrance regions of Brisbane Water. These models will help inform decisions about the management of navigation and dredging issues.

As part of the Management Study and Plan, CLAM models will be developed at an additional six sites presented in **Figure 2**.

Figure 2: Possible Dredging Scenarios

During the consultation process, input will be sought from local residents, boat users and other relevant stakeholders as to what are the key dredging and navigation issues in Brisbane Water.

Community Input to the Study and Plan

In preparing the Management Study and Plan for Brisbane Water, the Estuary Management Committee will be seeking your input so that we can make sure that the future management of Brisbane Water is in line with the community's expectations and values.

Your input at an upcoming community workshop is requested. The purpose of this workshop is to allow for the exchange of ideas for the Management Study and Plan. Cardno Lawson Treloar will provide background information on the study and an update on work completed up until that time.

The workshop will be held on Saturday 4 April 2009 at the Erina Centre between 10:00am and 1:00pm.

The primary discussion topic for the workshop will be the management issues and objectives for the Brisbane Water Estuary.

Management issues are likely to include:

- The impacts of increased development in the Gosford area,
- Poor stormwater quality,
- Limited flushing in the upper reaches of the estuary,
- Inundation of low lying areas during storms,
- Siltation of waterways,
- Shoreline erosion,
- Poor water quality,
- Loss of saltmarsh and seagrass,
- Introduced plant and animal pest species,
- Conflict between different recreational activities,
- Lack of public access to the Brisbane Water shoreline, and
- The potential loss of heritage items.

To register your interest in attending the workshop, please RSVP to brisbanewater@cardno.com.au by 1 April 2009.

Appendix B3

Issues and Objectives Workshop

Community Consultation Workshop, 4th April 2009

Brisbane Water Estuary Management Study

Agenda

Location: Erina Centre
Time: 10:00 AM – 1:00 PM

Time	*Agenda Item*	*Presented By*
10:00 – 10:10 AM	Arrival and registration	-
10:10 – 10:25 AM	Welcome address	Mayor Holstein, Gosford City Council
10:25 – 11:00 AM	Presentation	Louise Collier, Cardno Lawson Treloar
11:00 – 11:15 AM	Break for tea and coffee	-
11:15 AM – 12:55 PM	Workshop session in groups	Each group table will have a team member to assist
12:55 – 1:00 PM	Workshop closing address	Louise Collier, Cardno Lawson Treloar

Brisbane Water Estuary Processes Study

The Brisbane Water Estuary Processes Study was adopted by Council in February 2009. The report may be viewed at http://www.gosford.nsw.gov.au/customer/document_gallery/brisbane-water-estuary/base_view.

Future Consultation

We would also like to invite you to attend one of three forthcoming workshops at which we will be seeking your feedback on management options for implementation as part of the Plan.

Please find below details of these upcoming workshops. Please register your interest in attending at brisbanewater@cardno.com.au, or by notifying one of the Cardno team members today.

Date: Tuesday, 19th May
Time: 1pm to 4pm
Location: Wagstaffe Hall - Cnr Mulhall Street and Wagstaff Avenue, Wagstaffe.

Date: Wednesday, 20th May
Time: 6.30pm to 9pm
Location: Gosford City Council Chambers - 49 Mann St Gosford.

Date: Thursday, 21st May
Time: 10am to 1pm
Location: South Woy Woy Progress Hall - 76 Woy Woy Road, Woy Woy.

Cardno LawsonTreloar

Brisbane Water

Estuary Management Study and Plan

Community Workshop: Erina Centre, 4 April 2009

Cardno LawsonTreloar

Workshop Agenda

- 10:00-10:10 - Arrival and Registrations
- 10:10-10:25 - Mayor's Welcome
- 10:25-11:00 - Presentation
- 11:00-11:15 - Break for coffee and tea
- 11:15-12:55 - Workshop Session
- 12:55-13:00 - Closing Address

Cardno LawsonTreloar

Mayor's Welcome

Councillor Chris Holstein

Cardno LawsonTreloar

Today's Workshop Team:

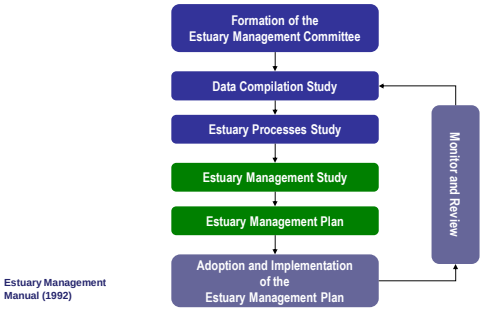
Louise Collier – Project Manager, Cardno
Tanja Mackenzie – Environmental Scientist, Cardno
Leo Drynan – Environmental Scientist, Cardno

Garry Chesnut, Director, Environment and Planning, GCC
Eddie Love, Manager – Integrated Planning, GCC
Ann Stewart, Advisor Environmental Planning, GCC

Presentation Outline

- What is the 'Estuary Management Process'?
- How does this fit with the 1995 Plan of Management?
- Fast Facts - Brisbane Water Estuary
- What did the Estuary Processes Study find?
- What will this Estuary Management Study address?
- What are some known Management Issues?
- What might be appropriate Management Objectives?
- Workshop Session – Values and Issues
- What happens Next?

Estuary Management Process



Estuary Management Manual (1992)

Background: Current Framework

- Brisbane Water Plan of Management (1995)
  - Adopted by Council 25 July 1995.
  - Prepared in response to increasing development pressures on Brisbane Water and it's foreshores.
  - Aimed to provide a sound framework within which to develop further planning for the area and to ensure that valuable estuarine resources are properly managed.
  - Brisbane Water Estuary Management Study and Plan will supersede the Plan of Management.

Brisbane Water Estuary – Fast Facts

Brisbane Water Estuary – Fast Facts

- Classification – “wave dominated” estuary.
- Catchment area – 165km².
- Water area – 27.2km².
- Condition – extensively modified.
- The estuary plays an important role with regards to the environment, recreational and commercial uses, and residential living.

What was the Purpose of the Estuary Processes Study?

- To identify the physical, ecological and biochemical processes of the estuary
- To define the baseline condition of the estuary to inform future management decisions;
- To review existing and future land uses

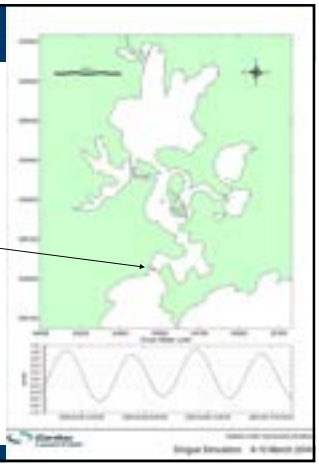
What did the Estuary Processes Study Consider?

- Hydrodynamics (water movement);
- Water Quality;
- Morphology (sediments and their movement);
- Ecology (flora and fauna);
- Heritage (Aboriginal and Non Aboriginal); and
- Recreation (Foreshore and Water based).

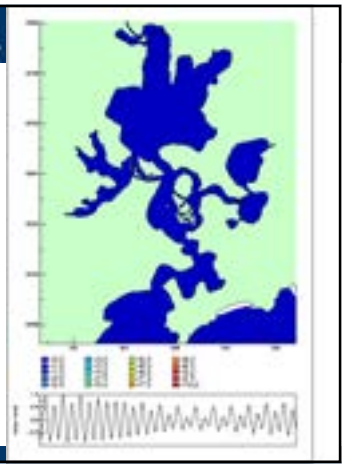
Hydrodynamics Particle Tracking

Assumed Starting Point

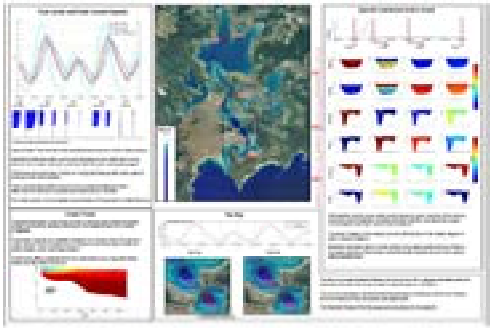
Tidal Cycle



Water Quality Flushing After a Catchment Runoff Event



What did the Estuary Processes Study Find?



Where can I see the Estuary Processes Study?

- Findings will feed into the Estuary Management Study and Plan.
- Now available on Council's website:

http://www.gosford.nsw.gov.au/customer/document_gallery/brisbane-water-estuary/base_view

What will the Estuary Management Study Involve?

- Identify Estuary uses, values and significance.
- Establish the Regulatory and management context.
- Identify management issues and objectives.
- Identify management options.
- Prioritise management options
- Recommend options for the Estuary Management Plan.

What are some known Management Issues?

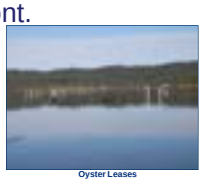
- Catchment Issues
  - Erosion and sedimentation;
  - Loss of riparian vegetation;
  - Stormwater quality (nutrients, sediments and heavy metals);
- Hydraulic Issues:
  - Limited flushing in upper reaches;
  - Foreshore erosion (wave attack and storm bite);
  - Inundation of low lying areas due to flooding and storm surge;
  - Sediment re-suspension (e.g. near St Hubert's Island);
  - Sea level rise.
- Geomorphological Issues:
  - Impacts of shoals on navigability (e.g. Ettalong);
  - Siltation of waterways;
  - Degraded sediment quality;
  - Acid Sulfate Soils;
  - Impacts of shoreline structures on foreshore processes;
  - Shoreline erosion (short term and long term).

Swell Exposed Areas

Stormwater Outlet

Known Management Issues Cont.

- Water Quality Issues:
  - Poor water quality;
  - Impacts of suspended solids on primary productivity;
  - Stratification after rainfall events.
- Ecological Issues:
  - Degradation of foreshore vegetation;
  - Introduced pest species;
  - Mosquitos;
  - Reclamation of tidal wetlands;
  - Restriction of tidal inundation of wetlands;
  - Loss of seagrass habitats;
  - Loss of saltmarsh;
  - Potential for algal blooms;
  - Poor knowledge of some species;
  - Disease outbreaks (e.g. oysters).
- Cultural Heritage Issues:
  - Unidentified indigenous and maritime heritage sites;
  - Loss of heritage items due to human activities and climate change.



Oyster Leases

Disturbed (left) and Undisturbed (right) Saltmarsh Habitat

Known Management Issues cont.

- Recreation
  - Conflicts between user groups;
  - Conflicts between recreation and ecology;
  - Lack of public access to the foreshore;
  - Inadequate recreational facilities;
  - Traffic congestion (land and water);
  - Safety on the waterway and at boat ramps;
  - Undesignated boat launching locations;
  - Scour due to boat wake;
  - Informal dinghy storage;
  - Loss of public amenity;
  - Navigational hazards;
  - Car and trailer parking;
  - Off-leash dogs;
  - Inadequate lighting of public areas;
  - Residential zoning of foreshore land.

What are the Overarching Management Objectives?

- To provide a strategic framework for the management of the Brisbane Water Estuary now, and into the future.
- To improve community awareness and understanding of the estuarine system through their involvement in the development and implementation of the Plan.
- To be consistent with the NSW Rivers and Estuaries Policy and with the principles of Ecologically Sustainable Development.

What will the Workshop Part of Today Involve?

- We would appreciate your input on:
  - How do you value Brisbane Water?
  - In what way do you feel Brisbane Water contributes to the general character of Gosford and the Central Coast?
  - What particular features or aspects of Brisbane Water are important to you?
  - What issues do you see occurring on or around the foreshores of Brisbane Water?
  - How would you like to see Brisbane Water managed into the future?

Workshop Zones

- Zone 1: Fagan's Bay
- Zone 2: Brisbane Water
- Zone 3: Woy Woy Reach
- Zone 4: Central Reach
- Zone 5: Kincumber / Cockle Bay
- Zone 6: Entrance Reach

What will be the Workshop Structure?

- Four Workstations:
  - Zones 1 and 2
  - Zones 3 and 4
  - Zone 5
  - Zone 6
- Feedback Forms
  - Please complete and place in the box provided
- Maps to annotate with issues
- Stay as long as you need (until 1pm).

What's Happens Next?

- Workshops: Developing Options for Management
  - 1:00 – 4:00 pm, 19 May 2009, Wagstaff Hall
  - 6:30 – 9:30pm, 20 May 2009, Gosford Council Chambers
  - 10am-1pm, 21 May 2009, South Woy Woy Progress Hall
  - Only need to attend one as they will all be the same
- RSVP again to brisbanewater@cardno.com.au

Cardno LawsonTreloar

Thank You

Morning tea is now served.

Please move to the workstation(s) you are interested in for small group discussions.

Community Feedback – Brisbane Water Estuary Management Study

Local residents' knowledge is very valuable; please take the time to fill in this feedback form. Please return by 17 APRIL 2009, either by placing your form in the "Community Feedback Form" box, or by emailing or faxing your response (see details at end of form).

Please provide us with the following details. We may wish to contact you to discuss some of the information with you. Please be assured your details will remain confidential.

Name: _____ Daytime Phone: _____

Address: _____ Email: _____

Postcode: _____ Organisation (if relevant): _____

SECTION ONE

As a local resident you have probably been a visitor to the Brisbane Water foreshore and used the facilities located there. You are also likely to have some ideas about what features of the waterways, foreshores and surrounding areas are important to you. Please rate how important each of the attributes listed below are to you by circling high, medium or low in the "Importance" column. Please feel free to provide additional comments where required.

Estuary Attribute or Feature	Importance (Please Circle)	Comments
Recreation, access and amenity – How important are the following features to you?		
Foreshore public facilities (e.g. public toilets, pathways, picnic/BBQ areas, etc.)	High Medium Low	
Public access (to parks, walking tracks etc.)	High Medium Low	
Water quality suitable for recreational purposes, such as fishing, swimming or boating.	High Medium Low	
Passive recreational use opportunities within open spaces near the water (e.g. walking or picnicking).	High Medium Low	
Active recreational use opportunities for open spaces near the water (e.g. cycling or fishing).	High Medium Low	
Safe use of the waterways by residents and visitors (e.g. observing boating speed limits and through maintenance of navigation channels).	High Medium Low	
Harmony between recreational users, commercial users and conservation of ecological values.	High Medium Low	
Private and public property – How important are the following features to you?		
Boating facilities such as boat ramps, moorings and dinghy storage areas.	High Medium Low	
Pleasant views of Brisbane Water and foreshores.	High Medium Low	
Protecting public and private property in relation to wave inundation, flooding, erosion and/or sea level rise (e.g. via seawalls or flood control works).	High Medium Low	
Access to the foreshores and waterways from your property.	High Medium Low	
The natural environment – How important are the following features to you?		
Water quality suitable for environmental conservation and aquatic health.	High Medium Low	
Native animals (e.g. birds, fish etc.)	High Medium Low	

Natural vegetation (e.g. saltmarshes) as habitat for animals.	High Medium Low	
Managing pollution and sedimentation associated with creeks and stormwater outlets.	High Medium Low	
European and Aboriginal heritage sites near or in the waterways.	High Medium Low	
Transport – How important are the following features to you?		
Using the waterways as a regular transport link.	High Medium Low	
Commercial activities and tourism – How important are the following features to you?		
Oyster leases as a local commercial activity.	High Medium Low	
Tour operators and vessels promoting tourism.	High Medium Low	
Transport operators and vessels providing public transport.	High Medium Low	
Foreshore businesses (e.g. marinas, restaurants, cafes, watercraft hire, slipway services, etc.)	High Medium Low	

SECTION TWO

When using the waterways and the surrounding foreshores you may have also encountered some issues or conflicts in use. These issues may include such things as inadequate facilities or public access, environmental concerns such as loss of vegetation or erosion, or areas affected by poor water quality. Please comment on any of these issues, or identify others that you have experienced, and give an indication of their location.

Issue	Location

Thank you for your participation in this survey. Additional comments are also welcome. Please attach additional pages as required. Please return this form to the box labelled "Community Feedback Forms" on 4 April 2009, OR fax or email your response. Return it to us via fax on (02) 9499 3033 or via email to brisbanewater@cardno.com.au by 17 April 2009.

Appendix B4

Options Development Workshops

Cardno LawsonTreloar

Brisbane Water

Estuary Management Study and Plan



Community Workshops: 19-21 May 2009

Cardno LawsonTreloar

Presentation Outline

- Estuary Management Study Status
- Results from Community Workshop
- General Management Objectives
- Management Goals
- Generic Management Options



Cardno LawsonTreloar

Brisbane Water
Estuary
and Bioregion Zones

Cardno LawsonTreloar

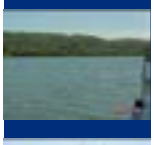
Estuary Management Study

- Estuary uses, values and significance.
- Regulatory and management context.
- Identify management issues/objectives.
- **Identify management options**.
- Prioritise management options
- Recommend management options.

Cardno LawsonTreloar

Community Workshop – 4 April 2009

- 6,500 invitation letters were sent out
- 117 attended workshop at The Hive
- Issues examined / identified
- Community Feedback Forms distributed



Cardno LawsonTreloar

Community Feedback Form

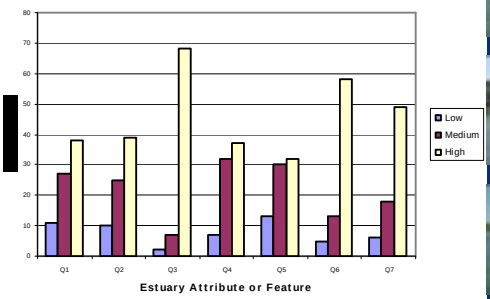
- 21 questions plus an open-ended section
- Two weeks for forms to be returned
- 77 forms were returned overall
  - 69 forms returned to Cardno
  - 8 forms returned to Council
- Included in the returned forms were 5 non-standard responses (i.e. longer submissions)

Community Feedback Form

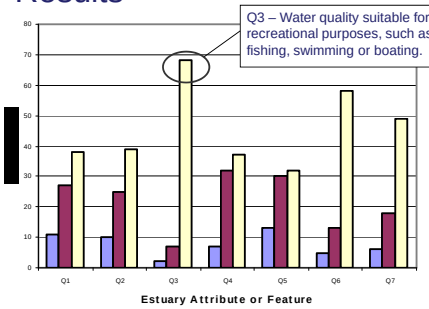
Recreation, Access and Amenity

Q1	Foreshore public facilities (e.g. public toilets, pathways, picnic/BBQ areas, etc.)
Q2	Public access (to parks, walking tracks etc.)
Q3	Water quality suitable for recreational purposes, such as fishing, swimming or boating.
Q4	Passive recreational use opportunities within open spaces near the water (e.g. walking or picnicking).
Q5	Active recreational use opportunities for open spaces near the water (e.g. cycling or fishing).
Q6	Safe use of the waterways by residents and visitors (e.g. observing boating speed limits and through maintenance of navigation channels).
Q7	Harmony between recreational users, commercial users and conservation of ecological values.

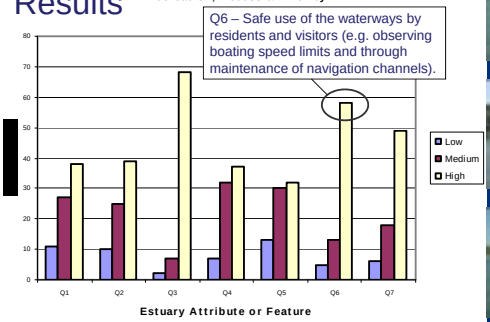
Community Feedback Results



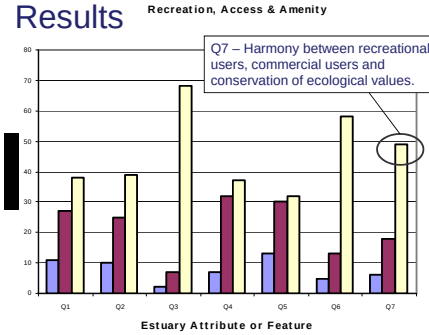
Community Feedback Results



Community Feedback Results



Community Feedback Results



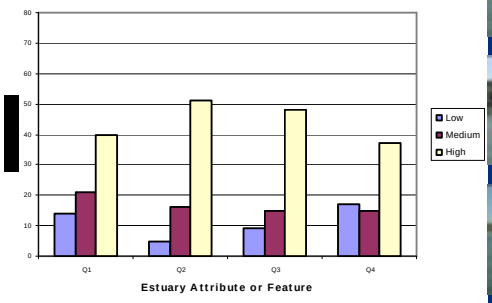
Community Feedback Form

Public and Private Property

Q1	Boating facilities such as boat ramps, moorings and dinghy storage areas.
Q2	Pleasant views of Brisbane Water and foreshores.
Q3	Protecting public and private property in relation to wave inundation, flooding, erosion and/or sea level rise (e.g. via seawalls or flood control works).
Q4	Access to the foreshores and waterways from your property.

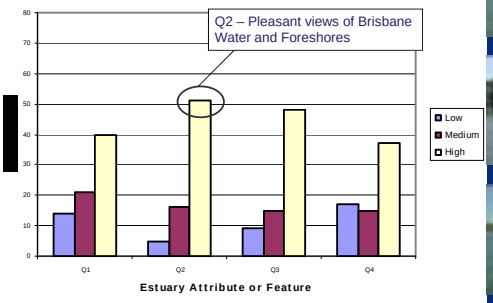
Community Feedback Results

Private & Public Property



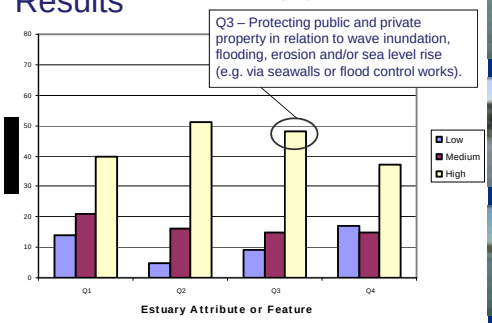
Community Feedback Results

Private & Public Property



Community Feedback Results

Private & Public Property



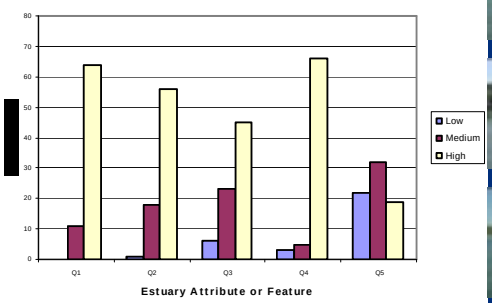
Community Feedback Form

The Natural Environment

Q1	Water quality suitable for environmental conservation and aquatic health.
Q2	Native animals (e.g. birds, fish etc.)
Q3	Natural vegetation (e.g. saltmarshes) as habitat for animals.
Q4	Managing pollution and sedimentation associated with creeks and stormwater outlets.
Q5	European and Aboriginal heritage sites near or in the waterways.

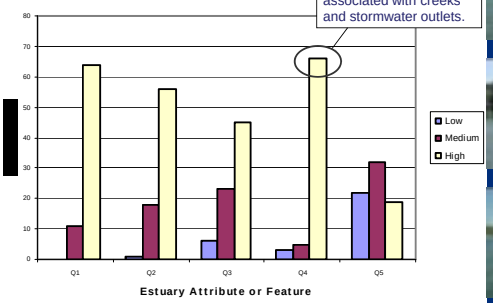
Community Feedback

The Natural Environment



Community Feedback

The Natural Environment



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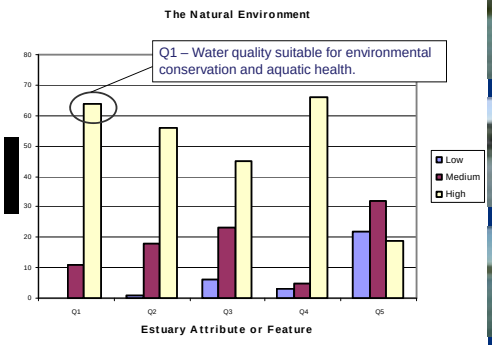

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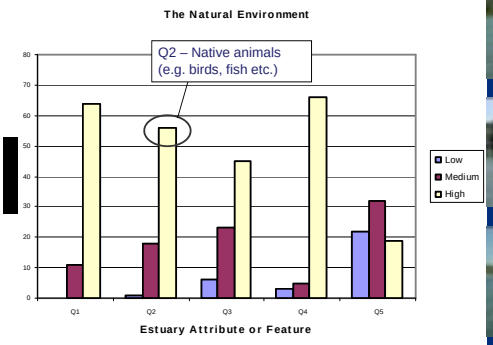


Community Feedback Form

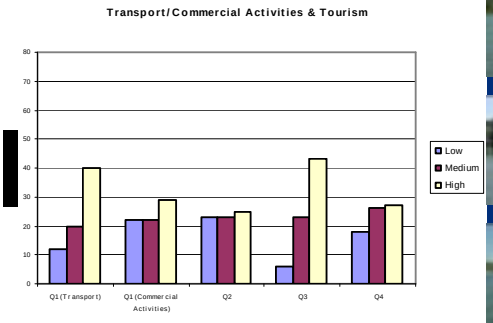
Transport

Q1	Using the waterways as a regular transport link.

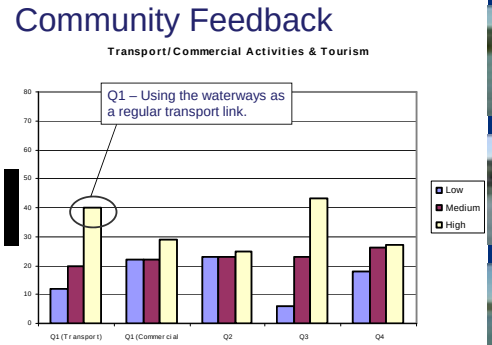
Commercial Activities and Tourism

Q1	Oyster leases as a local commercial activity.
Q2	Tour operators and vessels promoting tourism.
Q3	Transport operators and vessels providing public transport.
Q4	Foreshore businesses (e.g. marinas, restaurants, cafes, watercraft hire, slipway services, etc.)

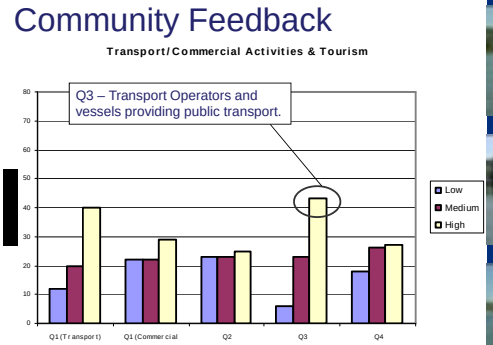
Community Feedback



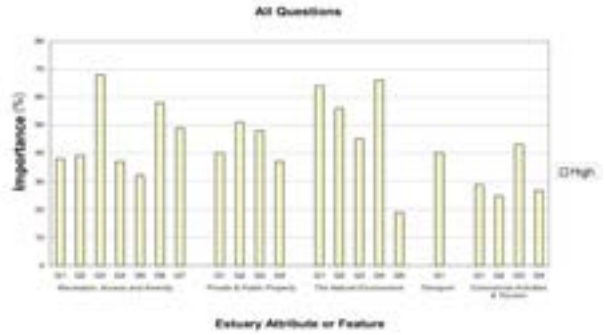
Community Feedback



Community Feedback



Community Feedback



Community Feedback – Issues

Zone 1

- 2 issues identified
- Key issues are sedimentation, poor water quality and lack of flushing.

Zone 2

- 17 issues identified
- Key issues relate to foreshore erosion, conflicting waterway uses & safety, seagrass wrack, water pollution, sedimentation.

Other comments about the broader area were also noted.

Community Feedback – Issues

Zone 3

- 13 issues identified
- Issues include sedimentation, poor flushing, boats exceeding speed limits.

Zone 4

- 15 issues identified
- Issues include sedimentation, foreshore erosion, soil compaction inhibiting plant growth, conflicts between different waterway uses.

Other comments about the broader area were also noted.

Community Feedback – Issues

Zone 5

- 24 issues identified
- Issues relate to weed infestation, loss of important habitat/flora and fauna, declines in number/size of some species, siltation, foreshore flooding, littering.

Other comments about the broader area were also noted.

Community Feedback – Issues

Zone 6

- 13 issues identified
- Issues relate to navigation difficulties, sedimentation, littering, poor water quality, seagrass wrack, fewer/smaller fish and shellfish.

Other comments about the broader area were also noted.

Management Objectives

General management objectives for the Estuary are:

- To provide a strategic framework for the management of the Brisbane Water Estuary, now and into the future.
- To improve community awareness and understanding of the estuarine system through their involvement in the development and implementation of the plan.
- To be consistent with the NSW Rivers and Estuaries Policy and the principles of Ecologically Sustainable Development.

Preliminary Management Goals

More specific management goals are outlined below:

AREA OF MANAGEMENT	GOAL
Water and Sediment Quality	To achieve a standard of water and sediment quality that protects and promotes a healthy aquatic ecosystem, while allowing aesthetic enjoyment and appropriate recreational use.
Sedimentary Processes	To minimise estuary sedimentation and erosion of the foreshore caused by the effects of human activities, or where natural sedimentary processes are impinging on certain human uses. To maintain access and amenity, as well as the navigability of the waterway, while recognising the natural sedimentary processes that occur in the estuary.
Foreshore Flooding	To minimise the impact of catchment flooding and foreshore inundation on existing and future development of the estuary foreshores, while maintaining ecosystem viability, and in accordance with Council's Floodplain Risk Management Plans.

Preliminary Management Goals

AREA OF MANAGEMENT	GOAL
Habitat and Species Conservation	To protect and retain existing habitat for estuarine species, rehabilitate degraded habitat and provide for ecological connectivity throughout the estuary.
Cultural Heritage	To acknowledge, conserve and commemorate (as appropriate) the Aboriginal and European heritage of the estuary and its foreshores.
Visual Amenity and Landscape Character	To maintain or enhance the visual experience of the landscape from vantage points in the both waterway and catchment.
Human Usage	To encourage and provide facilities for the appropriate recreational usage of the estuary waterways and foreshores while maintaining ecosystem viability.
Foreshore Development	To promote Ecologically Sustainable Development recognising the finite capacity of estuarine ecosystems. To recognise and report on inappropriate development.

Preliminary Management Goals

AREA OF MANAGEMENT	GOAL
Foreshore Development	To promote the strategic planning for the development of the Brisbane Water foreshore, taking into the account: -The potential impacts of climate change; -Access and amenity; and -The preservation of important foreshore habitats. To recognise and report on inappropriate foreshore development and take action to remedy where possible.
Commercial Development	To promote the Ecologically Sustainable Development of commercial activities and tourism within the estuary, recognising the finite capacity of estuarine ecosystems.

Preliminary Management Goals

AREA OF MANAGEMENT	GOAL
Governance	To establish a governance framework in order to facilitate ongoing implementation of the Plan.
Information, Communications and Education	To regularly provide information to the public about the estuary, including details of: - Current estuarine health (including aquatic ecosystem and human health indicators); - Current planning and development activities; - The impact that current and future land and waterway usage has on estuarine values; and - The contributions that the community can make toward reducing adverse impacts on, and enhancing the condition of, the estuary.

Possible Management Options

Types of management option:

- Works programs (e.g. one-off or ongoing works, structural or non-structural works)
- Planning mechanisms (e.g. development planning/restrictions)
- Education and awareness campaigns
- Monitoring programs
- Further studies or investigations

Possible Management Options

General Management Options from the NSW Government's Estuary Management Manual (1992) are given below:

ISSUE	MANAGEMENT OPTIONS
1 Build-up of sediments	A Reduction at the source B Gross pollutant traps C Filter sediment traps D Settlement ponds E Artificial wetlands
2 Excessive growth of aquatic plants	A Reduction of nutrients at source B Harvesting C Beach cleaning

Management Options

ISSUE	MANAGEMENT OPTIONS
3 Shoaling of estuary entrances	A Entrance Training works B Periodic Dredging C Sand by-passing D Do nothing
4 Preserving the tidal prism *Tidal prism* refers to the total volume of water moving past a fixed point on an estuary during each flood tide or ebb tide.	A Development controls (eg on reclamation and foreshore works) B Periodic Dredging

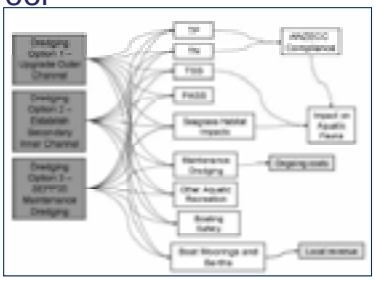
Management Options

ISSUE	MANAGEMENT OPTIONS
5 Loss of wildlife habitat	A Alternative sites for development B Creation of new habitat area
6 Foreshore erosion	A Do nothing B Relocation of assets C Foreshore stabilisation D Beach nourishment
7 Restricted foreshore access	A Land purchase B Development setback C Foreshore design

Management Options Analysis

Option	Capital Cost	Recurrent Cost	Net Present Value (7%, 50 years)	Recreation	Water Quality	Ecology	Heritage	Community Response	Council/State Agency Response	Compatible with Policies & Plans	TOTAL SCORE	RANK	Cost Benefit	RANK
Option 1	$300,000	$2,000	$327,601	0	0	0	2	-3	1	1	2	2	163,800.5	3
Option 2	$10,000	$0	$10,000	0	1	0	1	0	2	1	5	1	2000	1
Option 3	$250,000	$2,000	$277,601	1	1	0	-2	1	1	1	3	3	92,533.6	2

Management Options Analysis – CLAM Tool



Conceptual framework: Entrance CLAM

Estuary Management Plan

- Management actions for adoption
- Implementation strategy
- Program of monitoring & evaluation.

What Next?

- Compile and assess all the management options.
- Refine the list of management options with Council and DECC - June.
- Public exhibition of the Management Study – expected to be in August.
- Preparation of the Management Plan.

Questions?

Preliminary Management Goals

Goal	Notes
Water and Sediment Quality Goal: *To achieve a standard of water and sediment quality that protects and promotes a healthy aquatic ecosystem, while allowing aesthetic enjoyment and appropriate recreational use.*	The following notes accompany this goal: • This goal aims to meet the appropriate ANZECC (2000) guideline values for water quality objectives for dry weather (ambient) conditions at least 90% of the time. The relevant guideline values will need to be identified for the Brisbane Water Estuary. • The ultimate goal is unlikely to be achieved in the short-term and therefore incremental objectives are required. • With respect to pollutant loads from the catchment, the ultimate goal is the development of a strategic framework within which development is planned so that waterbody values can be identified. Data to support this include a study of relevant catchment processes and limits on the total load a waterbody can receive. Chapter 6 of Australian Runoff Quality (Engineers Australia, 2003) provides a methodology for such an assessment. • In the short term the goal is to improve wet weather water quality for parts of the estuary impacted by catchment inflows via the improvement of stormwater runoff quality to values typical of a less heavily urbanised catchment. This goal should be implemented in accordance with the principles of Water Sensitive Urban Design.
Sedimentary Processes Goal: *To minimise estuary sedimentation and erosion of the foreshore caused by the effects of human activities, or where natural sedimentary processes are impinging on human uses. To maintain access and amenity, as well as the navigability of the waterway, while recognising the natural sedimentary processes that occur in the estuary.*	The following notes accompany this goal: • This goal requires recognition of the natural sedimentary processes occurring in the estuary. It is noted that these sedimentary processes are likely to undergo change over time in relation to climatic processes such as El Niño/La Nina (i.e. dry vs. wet periods) and Climate Change. • Furthermore, this goal requires recognition of the need to maintain the tidal prism within the estuary for the purposes of flushing and scouring. • In some specific locations, including Ettalong, St Hubert's Island and Hardy's Bay, natural sedimentary processes are impacting on human usages and it may be necessary to undertake works to address this issue. • Activities in the catchment (such as construction) also contribute to sedimentation in the estuary. • The implementation of this goal requires the identification of agreed 'natural' rates of sedimentation for various embayments.

Goal	Notes
Foreshore Flooding Goal: *To minimise the impact of catchment flooding and foreshore inundation on existing and future development of the estuary foreshores, while maintaining ecosystem viability, and in accordance with Council's Floodplain Risk Management Plans.*	The following notes accompany this goal: • It is acknowledged that the Floodplain Risk Management Plans are the relevant plans to aid in the achievement of the management of foreshore flooding. • Therefore, the primary goal with respect to flooding is to ensure that any flood mitigation works proposed through the Floodplain Management Planning Process take under consideration estuarine processes such as estuarine water levels, wave attack, sedimentary geomorphology, ecological processes, and existing human uses. • The potential impacts of climate change on these estuarine processes, particularly catchment inflows and estuarine water levels, are key considerations in this respect.
Habitat and Species Conservation Goal: *To protect and retain existing habitat for estuarine species, rehabilitate degraded habitat and provide for ecological connectivity throughout the estuary.*	The following notes accompany this goal: • In the achievement of this goal there is a need to recognise the existing constraints (e.g. land use). • The primary goal is to retain existing habitat, with a view to re-establishment of aquatic and foreshore habitat where possible. • A secondary goal is to provide suitable, "healthy" habitat for recreationally and commercially important species such as fish, prawns and shellfish.
Cultural Heritage Goal: *To acknowledge, conserve and commemorate (as appropriate) the Aboriginal and European heritage of the estuary and its foreshores.*	The following notes accompany this goal: • There is a need for the identification of heritage sites in a spatial (GIS) format to assist with implementing this goal. However, information relating to Indigenous heritage should be held in a 'limited access' layer within Council's GIS due to its sensitive nature and managed in accordance with appropriate cultural consideration. • Commemoration should be undertaken as appropriate and with consultation, particularly for Aboriginal heritage items and places.
Visual Amenity and Landscape Character Goal: *To maintain or enhance the visual experience of the landscape from vantage points in the both waterway and catchment.*	The following notes accompany this goal: • This goal is expected to be difficult to measure and there is a data gap to limit the meaningful application of this goal.

Goal	Notes
Human Usage Goal: *To encourage and provide facilities for the appropriate recreational usage of the estuary waterways and foreshores while maintaining ecosystem viability.*	The following notes accompany this goal: • There is a need to balance the competing land- and water-based recreational uses. • This will include identification of environmentally sensitive areas for which less intensive uses may be more appropriate. • This goal has linkages with the Water Quality goal as parts of the estuary may not be suitable for primary contact recreational usage after rainfall events.
Foreshore Development Goal: *To promote the strategic planning for the development of the Brisbane Water foreshore, taking into the account:* • *The potential impacts of climate change;* • *Access and amenity; and* • *The preservation of important foreshore habitats.* *To recognise and report on inappropriate foreshore development.*	The following notes accompany this goal: • For the purposes of this goal, foreshore development is defined as that occurring in the intertidal zone and within 10m of the mean high water mark. • Historically, many residents owning foreshore properties have sought the opportunity to modify their property boundaries to enclose adjacent accreting shoreline. This has often led to restrictions on public access to the foreshore. In addition, where the observed accretion has been the result of a short term process and subsequently reverses, property owners have then tended to implement foreshore protection works along the modified property boundary. In many cases these structures are inappropriate (see below). • It is recognised that in some locations in the estuary, the natural sedimentary processes have been modified as a result of ad-hoc construction of foreshore structures such as jetties, ramps and seawalls, thereby contributing to localised erosion and/or sedimentation. • In the achievement of this goal, there is a need for the recognition of processes such as climate change.
Commercial Development Goal: *To promote the Ecologically Sustainable Development of commercial activities and tourism within the estuary, recognising the finite capacity of estuarine ecosystems.*	The following notes accompany this goal: • For the purposes of this goal, development is defined as land and waterway development for residential, commercial and industrial uses, as well as tourist development. • Commercial development should be undertaken in accordance with Council's *Corporate Vision for the City of Gosford*. • This goal will seek to provide for appropriate development, as well as identifying and preventing inappropriate development. • The process of 'redevelopment' will generally result in a more sustainable outcome than that which can be achieved with existing development. • In the achievement of this goal, there is a need for the recognition of processes such as climate change.

Goal	Notes
Governance Goal: *To establish a governance framework in order to facilitate ongoing implementation of the Plan.*	The following notes accompany this goal: • This goal will seek to ensure that the various Government agencies, authorities and other organisations involved in the different aspects of estuary management work together to allocate appropriate resources for implementation of the Plan. • It is recognised that ongoing liaison between these different groups will be an essential component of this goal.
Information, Communications and Education Goal: *To regularly provide information to the public about the estuary, including details of:* • *Current estuarine health (including aquatic ecosystem and human health indicators);* • *Current planning and development activities;* • *The impact that current and future land and waterway usage has on estuarine values; and* • *The contributions that the community can make toward reducing adverse impacts on, and enhancing the condition of, the estuary.*	The following notes accompany this goal: • It is recognised that there is a need for an emphasis on education to achieve all the goals. • Linkages between the Estuary Management Plan and State of the Environment reporting by Council are to be established. • There is a need to develop and maintain awareness within the community, public authorities and industry forums to communicate the objectives and goals for the management of the Brisbane Water Estuary.

Brisbane Water Estuary Management Study and Plan

Community Feedback – Options Development Workshops

We appreciate that, as a local resident and user of the Brisbane Water Estuary and its foreshores, you will probably have some ideas as to how you would like to see the estuary managed into the future. You may have some ideas for specific action or program of works that you feel are necessary to address a particular issue you have observed. We would be grateful if you could provide details of your suggested option(s) in the table provided below.

Please provide us with the following details. We may wish to contact you to discuss some of the options you suggest. Please be assured your details will remain confidential.

Name: _____ Daytime Phone: _____

Address: _____ Email: _____

Postcode: _____ Organisation (if relevant): _____

We would be grateful if you could return your completed form to us no later than **Friday 5th June 2009**.

Please fax your form to (02) 9499 3033 or email a scanned copy to brisbanewater@cardno.com.au. Alternatively, please post your form, Attention: Ann Stewart, Gosford City Council, PO Box 21, Gosford NSW 2250.

Suggested Option	Location	Zone

Appendix B5

Second Press Release and Newsletter

Community shapes future for Brisbane Water

Date:
01-06-2009 12:00 AM
Media Release:

The community has had its say in shaping the future of Brisbane Water, with over 80 community members attending the Brisbane Water Estuary Management workshops last week.

An information evening was held at the Erina Centre to present the findings of the Brisbane Water Estuary Process Study, followed by three community consultation workshops held at Wagstaffe, Gosford and Woy Woy South.

Councillor Peter Freewater said the community consultation events were aimed at capturing the thoughts, values and knowledge of the community regarding the sustainable management of the Brisbane Water Estuary.

"The level of interest shown in these workshops highlights that the people of Gosford identify strongly with Brisbane Water and want the estuary to persist in excellent condition into the future, for the benefit and enjoyment of their children and grandchildren", Clr Freewater said.

"The community response has been tremendous and reflects the passion the local community feel towards the estuary."

Several issues were raised as priority focus areas during the events. These included sedimentation, water quality, stormwater pollution, foreshore erosion, loss of important habitat for flora and fauna and changes in fish stocks.

A diversity of management options were considered including dredging, foreshore restoration works, construction of sea walls, signage, improved pollution management and monitoring programs, seagrass friendly moorings, improved access for recreation and maintenance of infrastructure.

The priority issues and management strategies raised during the workshops will contribute to the development of a Brisbane Water Estuary Management Plan. This plan is currently being prepared by consultants Cardno Lawson Treloar.

A draft Management Study is expected to be released for public exhibition during August 2009 and will be followed up with a draft Management Plan later in the year.

For community members who missed out on the opportunity to contribute, the Brisbane Water Estuary Management Study Feedback Form is available from the Gosford City Council web site (www.gosford.nsw.gov.au)

The deadline for contributions is Friday 5 June 2009.

For more information, please contact Ann Stewart on 4325 8885 or email ann.stewart@gosford.nsw.gov.au .

Brisbane Water Estuary Management Study and Plan

Community Update

July 2009

Background

Gosford City Council and the Department of Environment and Climate Change (DECC) are currently preparing an Estuary Management Study and Plan for Brisbane Water. This Management Study and Plan is supported by the NSW Government Estuary Management Program, in line with the State Government's Rivers and Estuaries Policy 1992.

The purpose of this study is to identify and recommend appropriate actions to manage the environmental, social and commercial aspects of Brisbane Water Estuary.

As part of this process, Gosford City Council has engaged **Cardno Lawson Treloar** Pty Ltd to prepare the Estuary Management Study and Plan.

The Estuary Management Study and Plan

The Brisbane Water Estuary Management Study and Plan will establish a strategic framework for the future management of Brisbane Water. The Study will summarise relevant management issues and objectives for Brisbane Water. A range of management options will be evaluated to address these issues. Based on consultation with the community, stakeholders and Gosford Council, recommendations will be made as to the preferred management options. These preferred options will be translated into management actions for implementation and will form the basis of the Management Plan.

This community newsletter provides a brief update of the progress of the Study and Plan.

Issues Workshop (4 April 2009)

A workshop was held at The Hive, Erina Fair, on 4 April 2009 at which the community was provided with an opportunity to identify any issues or problems they had observed on and around the Brisbane Water Estuary.

The workshop was a resounding success, with around 120 members of the community in attendance. Residents worked with members of the project team to map management issues for the estuary.

A total of over 190 issues were identified, with key issues including:

- Poor water quality and sedimentation associated with stormwater outlets and creeks;
- Sedimentation and foreshore erosion;
- Safe passage through navigation channels;
- Safety issues in relation to boat traffic (e.g. speeding); and
- Low rates of tidal flushing in some locations.

Copies of the final list of management issues, as well as the issues maps for the six management zones, are currently available for download from Council's website.
http://www.gosford.nsw.gov.au/customer/document_gallery/bwemp

Brisbane Water Estuary Processes Study Information Evening (18 May 2009)

A community information evening was conducted on 18 May 2009 at The Hive, Erina Fair, to communicate the scientific findings of the Estuary Processes Study, which was adopted by Council in February 2009.

A range of presentations were given by members of the study team, covering such aspects as:

- The Human Dimensions of Brisbane Water Estuary.
- What You Need to Know About Tides Waves and Sediments.
- How to Protect the Biodiversity of Brisbane Water?
- Identifying Fish Nursery Grounds in Brisbane Water.
- The Importance of Estuarine Saltmarsh Dynamics for Estuarine Foodwebs.

Copies of the presentations given can also be found on Council's website

Gosford City Council and Cardno would like to thank Dr Bill Gladstone from Newcastle University and Dr Iain Suthers from the University of New South Wales for their contributions on the night.

Brisbane Water Estuary Management Study and Plan

Community Newsletter

July 2009

Options Development Workshops (19-21 May 2009)

Having identified over 190 management issues occurring around the estuary, the next step was to consider how these issues might best be addressed.

Input was sought from the community at a series of three Options Development Workshops, held from 19-21 May 2009 at Wagstaffe, Gosford and Woy Woy.

The purpose of these workshops was firstly to identify specific actions that might be undertaken to mitigate these issues, and secondly to ensure that the estuary is managed in such as way as to seek to maintain or enhance its current condition.

The types of actions considered included:

- Works programs,
- Planning mechanisms,
- Educational and awareness campaigns,
- Monitoring programs, and
- Further studies.

In total, 50 people attended the workshops and worked with Council and Cardno to develop ideas that could be considered for implementation in the Management Plan. Additional submissions were also received via email and fax.

Examples of the types of actions suggested at the workshop include:

- Rehabilitate the saltmarshes at Yattalunga Bay.
- Provide lockable dinghy storage racks.
- Promote Brisbane Water as an eco-tourism destination.
- Undertake a program of dredging to improve navigation.
- Provide an additional culvert under Brisbane Water Drive causeway to promote tidal flushing.

Options Assessment

The full list of management options suggested by the community and other stakeholders will be now be compiled, assessed and ranked using a multi-criteria matrix analysis.

The multi-criteria matrix analysis seeks to outline a prioritised list of options that provide the greatest benefit across all features and/or uses of the estuary. The top ranking options will then form the Management Plan and a strategy will be developed for implementation.

What's Next?

The Draft Brisbane Water Estuary Management Study is anticipated to be placed on public exhibition for comment in September.

After all submissions have been compiled and addressed, the Management Study will be finalised and work will begin on the Brisbane Water Estuary Management Plan.

Further information, including notes and presentations from the various workshops, can be found on Council's website at:

http://www.gosford.nsw.gov.au/customer/document_gallery/bwemp

Feedback can be directed to the project team via email: brisbanewater@cardno.com.au.

Gosford City Council Central Coast

Cardno LawsonTreloar

Department of Environment & Climate Change NSW

Appendix C

Report on the Ecological Impacts of Current Management

Assessment of the Ecological Consequences of Gosford City Council's Existing Management for Brisbane Water Estuary

A Report to Cardno Lawson Treloar

THE UNIVERSITY OF NEWCASTLE AUSTRALIA

NEWCASTLE INNOVATION™

Revised Final Report 7 October 2009

Assessment of the Ecological Consequences of Gosford City Council's Existing Management for Brisbane Water Estuary

Preamble

This report assesses the consequences, for Brisbane Water estuary, of Gosford City Council's management of its natural resources. This assessment is part of the development of the Brisbane Water Estuary Management Plan. The assessments relate to reports provided to the University of Newcastle by Cardno Lawson Treloar.

Each report was read and assessed for its potential to impact (positive, negative, neutral) the biodiversity and ecological processes of Brisbane Water estuary. The assessments were based on the following principles:

1. *Boundaries*: management actions were considered relevant to Brisbane Water estuary when they occurred within the Brisbane Water catchment and within the estuary boundaries as defined in the Brisbane Water estuary process study. Management plans that were based outside Brisbane Water's catchment were not included.

2. *Downstream impacts and benefits*: excessive silt entering the estuary is likely to have negative impacts on biodiversity and habitats (e.g. direct smothering, interference with filter-feeding organisms) and ecological processes (e.g. increasing turbidity will reduce primary productivity of algae and seagrasses) (Edgar and Barrett 2000; Cummings et al. 2003; Ralph et al. 2006). Silt may also carry contaminants that may have negative cumulative impacts on biodiversity (e.g. through increased morbidity and mortality) (Ralph et al. 2006). Catchment management that leads to improvements in the quality of riparian vegetation and/or creek water quality is likely to have positive outcomes for the condition of the estuary (Bunn and Arthington 2002; Gillanders and Kingsford 2002; Land & Water Australia 2009).

3. *Cumulative benefits and connectivity*: positive impacts in one area of the estuary are likely to be beneficial to the wider estuary because of the ecological and physical connectivity that results from the movement of water, estuarine food webs, and animal movements. Illustrations of the scale of connectivity that exist in Brisbane Water estuary are provided in the Estuary Processes Study report (Cardno Lawson Treloar 2008). Many of the management actions were assessed to have positive impact on the estuary. These management actions frequently involved small sections of creeks that ultimately drain into Brisbane Water. Taken together, the effect of all these small-scale management actions is likely to be beneficial for the biodiversity and ecological processes of Brisbane Water.

4. *Net effects*: some management plans included a range of actions, some of which are likely to have negative consequences for biodiversity and ecological processes. For example, the construction of seawalls to eliminate shoreline erosion reduces shoreline habitat complexity and a substantial proportion of the estuary's shoreline has already been converted to seawalls (Sainty and Roberts 2007). Seawalls modify shoreline biodiversity and ecological processes compared with natural shorelines (Chapman 2003, Chapman and Roberts 2004). Where a plan included several actions (e.g.

seawall construction, pollution reduction, debris removal, riparian rehabilitation) the potential net effect from all actions was determined.

5. *Implementation and monitoring*: the assessments assume that work is being implemented as outlined in the management plan. Monitoring results that evaluate the effectiveness of the management plans were not reviewed. Therefore, these assessments are an appraisal of the potential effects of the management plans rather than a judgement of their actual outcomes.

Overall Assessment

The overall effect of these plans of management is likely to be beneficial for Brisbane Water estuary. Twenty-one plans of management were assessed. Four plans are likely to have a neutral impact on Brisbane Water estuary, 17 plans are likely to have a positive impact. Only two plans involved management at the scale of the entire estuary: the foreshore parks plan of management, Brisbane Water Plan of Management 1995-2000. However, the net effect of the majority of plans that addressed local issues is likely to be beneficial for the estuary. Benefits are likely to come from rehabilitation of riparian vegetation, community education, creek and drain maintenance that reduces excessive sediment deposition downstream during flood events, maintenance of gross pollutant traps, installation and maintenance of constructed wetlands and detention basins, protection of biodiversity, and pollution control. Neutral impacts were associated with plans with a major focus on routine inspection and maintenance, management of foreshore parks without habitat rehabilitation, and passive recreational activities.

The information contained within the plans (scope of works, rationale, environmental assessment) was sufficient for an assessment of their ecological consequences. A feature missing from many plans (in particular those relating to creek maintenance) was their relationship to an existing Council policy or strategy relating to environmental or natural resource management. It was therefore unclear how the management of these local issues integrates with Council's broad aims and objectives for the management of Brisbane Water estuary.

A/Prof William Gladstone
7 October 2009

Summary of Assessments

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Concrete Pipes under Rail at Brief Street Woy Woy	Brief Street adjoins Phegans Bay	Considers inspection routine only to ensure safety of rail property.	There are no works detailed in plan that could have potential to impact on adjacent waterbody. **Assessment: neutral impact on Brisbane Water estuary biodiversity and ecological processes**
Everglades Main Drain Draft Floodplain Maintenance Plan	The Everglades Main Drain empties into Correa Bay, downstream of the Railway Street boat ramp.	Whilst the plan includes under-scrubbing of some riparian vegetation and removal of aquatic weeds, there is little work proposed near where the creek exists into Correa Bay.	There will only be positive outcomes for Brisbane Water by: (i) identifying opportunities to retain, protect and rehabilitate areas of native riverbank and aquatic vegetation; and (ii) the intention to improve community education and involvement in managing the creek areas to reduce impacts of dumping, nutrient inputs, weed invasion, vandalism and other threats to water quality and remnant vegetation. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**
Initial and Ongoing Maintenance to Erina Levee, Maintenance Plan No 02.02	Erina Creek, which drains into Brisbane Water.	Maintenance of the levee, including removal of trees, mowing, reducing weed growth, repairing erosion, and debris removal.	The area where Erina Creek enters Brisbane Water has a high biomass of macroinvertebrates in seagrass (Gladstone 2006). This area also has a lengthy flushing time of 42 days (Cardno Lawson Treloar 2008) and is therefore vulnerable to excessive sedimentation. Maintenance of the levee could contribute some fine sediment to Erina Creek via removal of trees, mowing and debris removal. It could also reduce sediment inputs from the repair of erosion. It is, on balance, unlikely to lead to increased sedimentation in Brisbane Water estuary. **Assessment: neutral impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Kulara Avenue Creek West Gosford	The creek is located between Pacific Highway and Fagan's Bay, West Gosford. The creek starts midway between Pacific Hwy and Bel Hilton Parade, runs through Kulara Avenue Box Culvert before discharging into Fagan's Bay in Brisbane Water.	It is proposed to undertake initial and regular ongoing maintenance to the creek. The purpose of the work is to remove litter and sediment from the creek bed and remove three selected mangrove trees (*Avicennia marina*) and overgrown vegetation from the creek bed that restrict stormwater flow during flood events. There will also be dredging to a depth of 300 mm and the subsequent removal of *A. marina* mangrove seedlings.	The removal of the mangroves would decrease habitat but would not be significant as there is a very large mangrove habitat in the immediate vicinity of Fagan's Bay. Spraying of the herbicide has the potential to impact on non-target natives through over-spray, however, the potential for any significant impact is low. Positive impacts include the removal of rubbish from the creek and the rehabilitation of riparian vegetation and other bank stabilisation works, likely to have positive outcomes for water quality in the creek water. Fagan's Bay has a relatively high flushing time of 2-3 days (Cardno Lawson Treloar 2008) so any short-term increased in sediment load associated with dredging and mangrove removal is unlikely to have long-term impacts. Fagan's Bay is important for the biodiversity of Brisbane Water seagrass because it contains a distinctive assemblage of macroinvertebrates not found elsewhere in the estuary (Gladstone 2006). Care should therefore be taken to ensure works proceed as proposed. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Ongoing Maintenance to part of Wingello Creek Main Rail line to Pacific Hwy No. 4-02	Wingello Creek drains into Narara Creek, which drains into Fagan's Bay, Brisbane Water.	Debris is to be cleared annually or as required following a flood event. Removal of growing trees is to be undertaken annually. Spraying of typha is to be undertaken twice yearly in spring and autumn.	This section of Wingello Creek is a man-made channel. The only potential impact would be from the spraying of typha with herbicide, however, the potential for any significant downstream negative impacts on the estuary is low. Improvement in riparian vegetation is likely to have positive outcomes for water quality and ultimately for water quality in Narara Creek and downstream areas. Fagan's Bay has a relatively high flushing time of 2-3 days (Cardno Lawson Treloar 2008) so any short-term increased in sediment load caused by removal of debris or bank disturbance is unlikely to have long-term impacts. Fagan's Bay is also important for the biodiversity of Brisbane Water seagrass because it contains a distinctive assemblage of macroinvertebrates not found elsewhere in the estuary (Gladstone 2006). The mouth of Narara Creek is significant for the biodiversity of Brisbane Water estuary because the unvegetated sediments contain a distinct assemblage of macroinvertebrates and the area has the second-highest conservation value (Gladstone and Shokri 2007). Maintenance of the biodiversity and ecological processes of Fagan's Bay and the mouth of Narara Creek are important for the entire estuary. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Ongoing Maintenance to part of Wyoming Creek Landcom Estate Jarrett St Wyoming No. 4-05	Wyoming Creek, which drains into Narara Creek, which drains into Fagan's Bay, Brisbane Water.	Bush regeneration works (including weed removal) and some general clearing of rubbish and organic debris from the creek.	Spraying of the herbicide has the potential to impact on non-target natives through over-spray, however, the potential for any significant negative impact is low. Improvement in riparian vegetation and removal of organic debris is likely to have positive outcomes for water quality in the creek water entering Narara Creek, Fagan's Bay and ultimately Brisbane Water estuary. Fagan's Bay has a relatively high flushing time of 2-3 days (Cardno Lawson Treloar 2008) so any short-term increased in sediment load caused by removal of debris or bank disturbance is unlikely to have long-term impacts. Fagan's Bay is also important for the biodiversity of Brisbane Water seagrass because it contains a distinctive assemblage of macroinvertebrates not found elsewhere in the estuary (Gladstone 2006). The mouth of Narara Creek is significant for the biodiversity of Brisbane Water estuary because the unvegetated sediments contain a distinct assemblage of macroinvertebrates and the area has the second-highest conservation value (Gladstone and Shokri 2007). Maintenance of the biodiversity and ecological processes of Fagan's Bay and the mouth of Narara Creek are important for the entire estuary. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Ongoing Maintenance to part of Wyoming Creek Main Rail line to Pacific Hwy No. 4-03	Wyoming Creek, which drains into Narara Creek, which drains into Fagan's Bay, Brisbane Water.	Channel maintenance to prevent flooding. Debris is to be cleared annually or as required following a flood event. Removal of growing trees to channel and retarding basin is to be undertaken annually. Spraying of typha to the channel is to be undertaken twice yearly in spring and autumn.	The creek in this location is a man made channel. Spraying of herbicide may impact on non-target natives, however, the potential for any significant impact is low. Provided care is taken with silt excavation work to minimise turbidity, the removal of silt will remove associated contaminants and prevent excessive silt being transported and deposited downstream during flood events. This will minimize potential negative effects of siltation on creek and estuary biodiversity and ecological processes. Fagan's Bay has a relatively high flushing time of 2-3 days (Cardno Lawson Treloar 2008) so any short-term increased in sediment load caused by removal of debris or bank disturbance is unlikely to have long-term impacts. Fagan's Bay is also important for the biodiversity of Brisbane Water seagrass because it contains a distinctive assemblage of macroinvertebrates not found elsewhere in the estuary (Gladstone 2006). The mouth of Narara Creek is significant for the biodiversity of Brisbane Water estuary because the unvegetated sediments contain a distinct assemblage of macroinvertebrates and the area has the second-highest conservation value (Gladstone and Shokri 2007). Maintenance of the biodiversity and ecological processes of Fagan's Bay and the mouth of Narara Creek are important for the entire estuary. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Ongoing Maintenance to part of Brady's Gully Creek Wyoming, North Gosford No. 4-01	Brady's Gully Creek, which drains into Narara Creek, which drains into Fagan's Bay, Brisbane Water.	Channel maintenance to prevent flooding. Work includes weed spraying, silt excavation, removal of trees and debris from creek, rubbish removal from creek and surrounds.	Spraying of herbicide has the potential to impact on non-target natives through over-spray, however, the potential for any significant impact is low. Whilst there is some silt excavation work described, provided care is taken to minimise turbidity, the removal of silt will also remove associated contaminants. Removal of dead trees will mobilise some sediments but the resulting impact should be minimal provided care is taken. Removal of silt will also prevent excessive silt being transported and deposited downstream during flood events, thereby minimizing potential negative effects of siltation on creek and estuary biodiversity and ecological processes. Fagan's Bay has a relatively high flushing time of 2-3 days (Cardno Lawson Treloar 2008) so any short-term increased in sediment load caused by removal of debris or bank disturbance is unlikely to have long-term impacts. Fagan's Bay is also important for the biodiversity of Brisbane Water seagrass because it contains a distinctive assemblage of macroinvertebrates not found elsewhere in the estuary (Gladstone 2006). The mouth of Narara Creek is significant for the biodiversity of Brisbane Water estuary because the unvegetated sediments contain a distinct assemblage of macroinvertebrates and the area has the second-highest conservation value (Gladstone and Shokri 2007). Maintenance of the biodiversity and ecological processes of Fagan's Bay and the mouth of Narara Creek are important for the entire estuary. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Open Channel in Melaleuca Park Tascott No. 18-1	The channel runs through Melaleuca Park, Tascott, discharges into a piped system which runs under Glenrock Parade and the main railway line and then discharges into Brisbane Water.	Maintenance is required to ensure design stormwater flows are maintained within the rock lined channel and that the gross pollutant trap (GPT) is cleaned to prevent downstream pollution and blockage of culverts and that rockwork is repaired in the event of a collapse.	The channel is and rock lined and includes a GPT and trash rack. This means that removal of rubbish and sediment is achieved with minimal if any negative impact on the estuary. The major outcome of the works (assuming they are carried out regularly) will be a reduction in silt outflow, thereby contributing to maintenance of water quality and ecological processes in the estuary. Seagrass beds can trap sediment. However, the area where this channel discharges has no/minimal seagrass (Cardno Lawson Treloar 2008). Therefore, these works are important for preventing additional sediment entering Brisbane Water. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**
Part of Coorumbine Creek, West Gosford, Maintenance Plan No 17.01	Discharges into Fagan's Bay	Maintenance to reduce flooding, including remove any trees growing in the floodway, remove any debris, remove any "excessive" reed or fern growth, remove any foreign items from the whole channel, and excavate silt.	Fagan's Bay has a relatively high flushing time of 2-3 days (Cardno Lawson Treloar 2008) so any short-term increased in sediment load caused by removal of debris, bank disturbance, and silt excavation is unlikely to have long-term impacts. Fagan's Bay is important for estuary biodiversity because it contains a distinctive assemblage of seagrass macroinvertebrates not found elsewhere in the estuary (Gladstone 2006). The plan is likely to be beneficial because it will involve removal of silt, which would otherwise be deposited into Fagan's Bay during a flood. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Worthing Road Creek Constructed Wetlands Operation and Maintenance Manual	Wetlands discharge into Erina Creek	Successful maintenance and management of the constructed wetland system at the confluence of Worthing Road Creek, Karalta Creek and a third unnamed creek located between Terrigal Drive and Karalta Road at Erina.	This will be beneficial to the water quality of Brisbane Water estuary because of its potential to strip nutrients and silt from water entering Erina Creek. The area where Erina Creek enters Brisbane Water has a high biomass of macroinvertebrates in seagrass (Gladstone 2006). This area is therefore ecologically significant for estuarine food webs and likely to be negatively affected by declines in water quality. This area, however, also has a lengthy flushing time of 42 days (Cardno Lawson Treloar 2008) and is therefore vulnerable to short-term declines in water quality. Long-term maintenance of water quality is therefore important for this area. The benefits of these works are conditional, however, on its proper management and maintenance. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**
Maintenance Plan No. 13 – 1, Woy Woy Pool Drain	Alpha Road Woy Woy, which drains into Brisbane Water	Maintenance to reduce flooding, including spraying of typha, silt removal, tree planting, and rubbish removal.	Works may mobilize small amounts of sediment in the short-term. Plant growth in drain will strip nutrients from water. The area where the drain enters the estuary has large areas of seagrass (Cardno Lawson Treloar 2008), which are vulnerable to sedimentation. The area also has a low swell wave height (Cardno Lawson Treloar 2008), which minimizes the opportunity for accumulated sediment to be re-distributed. Maintenance will prevent excessive silt being transported and deposited downstream during flood events, thereby minimizing potential negative effects of siltation on estuary biodiversity and ecological processes. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Wyoming Creek Floodplain Maintenance Plan Final Report	Wyoming Creek, which drains into Narara Creek, which drains into Fagan's Bay and Brisbane Water.	Maintain design flows and levels for a 1% AEP flood event as defined within the Wyoming Creek Floodplain Management Plan, minimise damage to private and public infrastructure, maintain and enhance Wyoming Creek's natural environment wherever possible.	The Maintenance Plan provides a range of actions in five maintenance management areas, the actions including macrophyte management, silt removal, tree and shrub removal from rock walls, and debris removal. If the maintenance work proceeds as planned the effect will be to reduce the amount of silt deposited and therefore transported into Narara Creek during flood events. This is likely to be beneficial for water quality (and therefore biodiversity) in Narara Creek, Fagan's Bay and Brisbane Water estuary. Fagan's Bay has a relatively high flushing time of 2-3 days (Cardno Lawson Treloar 2008) so any short-term increased in sediment load caused by removal of debris or bank disturbance is unlikely to have long-term impacts. Fagan's Bay is also important for the biodiversity of Brisbane Water seagrass because it contains a distinctive assemblage of macroinvertebrates not found elsewhere in the estuary (Gladstone 2006). The mouth of Narara Creek is significant for the biodiversity of Brisbane Water estuary because the unvegetated sediments contain a distinct assemblage of macroinvertebrates and the area has the second-highest conservation value (Gladstone and Shokri 2007). **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Broken Bay Beaches Coastal Management Plan	Putty Beach, Ocean/Umina Beach, Pearl Beach, Patonga Beach, Broken Bay, Brisbane Water Entrance, Headland, Bluff and Rock Shelf Areas	Only management related to Brisbane Water Entrance and Headland, Bluff and Rock Shelf Areas are relevant, all other areas are located outside Brisbane Water estuary and its catchment.	Management actions related to erosion, amenity, facilities, water quality, marine ecology, bank stability, and navigation. Likely to have local positive impacts around beaches, foreshores and into the southern reaches of Brisbane Water estuary and the intertidal rock shelves at the entrance to Brisbane Water. The area at the entrance to Brisbane Water (including the rock shelf) has the highest conservation value in the estuary for the representation of species diversity (Gladstone and Shokri 2007). Therefore these management actions could make a substantial contribution to biodiversity conservation. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**
Plan of Management, Foreshore Parks	Foreshores of Brisbane Water estuary and waterways in its catchment (exact areas not shown in Plan)	Numbers of actions listed to address issues of Number of Foreshore Parks, Development and Improvement, Maintenance, Management, Impact of Development, Use of Open Space Areas for Events, Fees & Charges, Information on Foreshore Parks, Plan of Management Evaluation, Plan of Management Action Plan, Plan of Management Land Register	Plan requires consideration of environmental effects: “The development of foreshore parks should be incorporated with protection of the natural environment.” Specific actions may lead to localized negative impacts on Brisbane Water estuary e.g. mowing practices, installation/upgrade of facilities such as boat ramps. However, overall impacts likely to be minimal when undertaken within the framework of the Brisbane Water Plan of Management. Potential to use foreshore parks more actively for environmental education. **Assessment: neutral impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Plan of Management for Gosford Foreshore	Gosford foreshore, the Broadwater	To allow the use of the land to provide for water access, passive recreation, cultural experience and entertainment	Potential for short-term and local negative impacts from special events, such as litter entering shallow water, but able to be minimized with appropriate controls. **Assessment: neutral impact on Brisbane Water estuary biodiversity and ecological processes**
Gosford City Council Supplementary Sustainability Report 2008	Gosford LGA	Council intends that this Sustainability Report will support its vision and assist Council and the community to work towards the common goal of sustainable development.	Summary of Gosford's environment under the State-Pressure-Response Framework. A useful resource for raising community awareness and therefore potentially able to increase community engagement. Indirect positive benefits likely for the estuary from increased community awareness and engagement. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**
Worthing Creek Detention Basin and Parkland, Plan of Management	Worthing Creek drains into Erina Creek, which enters Brisbane Water estuary.	To provide two detention basins which will slow stormwater flows up to the 1 in 100 year storm, and thereby greatly reduce the problems of inundation and damage caused to downstream areas. Specific works include detention basins, constructed wetlands, bush regeneration, improved access, and maintenance.	Assuming the system is functioning according to plan and there is regular maintenance, it is likely to reduce downstream impacts of flood, capture silt, and strip nutrients. The area where Erina Creek enters Brisbane Water has a high biomass of macroinvertebrates in seagrass (Gladstone 2006) and is therefore ecologically significant for food webs and likely to be negatively affected by declines in water quality. This area also has a lengthy flushing time of 42 days (Cardno Lawson Treloar 2008) and so is vulnerable to short-term declines in water quality. Long-term maintenance of water quality is important. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Yattalunga Foreshore Reserve, Draft Plan of Management	Yattalunga, Brisbane Water	Overall aim is improvement of the foreshore area for the benefit of the surrounding community. The Plan includes a number of specific actions to address the environmental effects of the reserve on the estuary, including improved drainage and pollution control, regrading to overcome local flooding and control of surface runoff.	The area adjacent to the reserve has a number of important ecological values. Two species of seagrass are represented: *Zostera capricorni* and *Posidonia australis* (Gladstone 2006, Cardno Lawson Treloar 2008). The *Z. capricorni* seagrass in the vicinity of the reserve has the greatest diversity of macroinvertebrates in the estuary (Gladstone 2006, Gladstone and Shokri 2007) and among the highest density of macroinvertebrates (Gladstone 2006). Therefore the outcomes of this plan are likely to have a significant impact on the biodiversity and ecological processes of the estuary. Actions to control pollution to the estuary originating from the reserve and surrounding areas will have a positive impact on the nearby seagrass. However, the proposal to construct a seawall to ameliorate shoreline erosion may have local negative impacts on biodiversity by reducing the amount of ecological niches and expanding the length of estuary foreshore converted to seawalls. Construction of seawalls that provide a range of ecological niches is preferred. The overall impact of all actions is likely to be positive. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

Plan	Location, relationship to estuary	Main actions/works/objectives	Assessment
Ettalong Beach Reserve Plan of Management	Ettalong Beach, Brisbane Water	Plan was prepared to resolve issues associated with: preservation of the beach, conservation of the foreshore reserves open space, appreciation of the reserve's character, and arrival of the new Fast Ferry.	The area of the estuary adjacent to Ettalong Beach has the highest conservation value in the estuary (for representation of species diversity) because it contains the greatest number of species not found elsewhere in the estuary (Gladstone and Shokri 2007). This plan includes a number of specific actions likely to produce positive impacts on the beach ecosystem (such as retain dunes and vegetation, build appropriate dune vegetation fence, install a bioswale to filter road runoff, rehabilitate dune vegetation, remove weeds). Connectivity of beach and estuarine habitats means that protection of the beach ecosystem will have flow-on benefits to the estuary. Retention of near-natural ecological processes and biodiversity of this beach ecosystem, allowing for its high level of human usage, will contribute to maintenance of estuarine ecological processes and biodiversity. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**
Brisbane Water Plan of Management 1995/2000	Brisbane Water	The plan provides detailed management guidelines for development. The need arose out of strong community concern to preserve the unique character of Brisbane Water whilst enabling people to enjoy its use. Plan provides specific actions relating to: habitat management, water quality, heritage, water use, water depth and sedimentation, channel and foreshore protection, residential structures, tourism, transport, access, commercial development, and planning provisions.	The range of actions, if implemented, would provide a positive impact for biodiversity and ecological processes of Brisbane Water estuary. **Assessment: positive impact on Brisbane Water estuary biodiversity and ecological processes**

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Appendix D

Management Issues

Issue No.	Zone	Location	Management Issue	Ranking
1	2	As mapped.	Sediment build at existing boat ramps prevents boat access for all boats other than dinghies at Saratoga, Green Point and Davistown (opposite Killcare Convent).	L
2	2	As mapped.	Barrier to access near Merindah Ave, north of Wharf Reserve, Green Point.	L
3	2	As mapped.	Existing boat ramp near Iguana Joe's inadequate. Suggest upgrade for general boating use (potential funding through NSW Maritime).	L
4	2	As mapped.	Sediment build-up, algae/weed build up (rotting smell) and pollution preventing boating access and causing problems regarding amenity at Victory Pde, Tascott. Issue exacerbated by stormwater discharge. Need for improved pedestrian access.	L
5	2	As mapped.	Sediment build-up and pollution entering water from stormwater drains near 27 Coogee Rd, Point Clare/Noonan Point. Resident requested more sea walls (built by owners).	M
6	1	As mapped.	Fagan's Bay: sediment build-up and weed/algae infestation over last four years. Limited flushing from Coorumbine Creek.	L
7	1	As mapped.	Railway bridge/structure obstructing water movement and influencing natural flushing resulting in sediment build-up.	M
8	2	As mapped.	Saratoga Channel: dredging option to allow it to be re-opened for navigation and help flush Saratoga inlet. Unsafe navigation due to sediment build-up. Observed reduction in the velocity of currents in major navigation channels.	L
9	2	As mapped.	Entrance to Paddy's Channel drop over: provision of safe navigation channel (dredging). No other access in and out of Brisbane Water. Seven year, gradual build-up of sediment. Observed reduction in velocity of currents.	M
10	2	As mapped.	Sediment build-up at Gosford Harbour preventing yacht access.	L
11	2	As mapped.	Bank/foreshore erosion and sea wall collapse at Gosford Scout Hall.	L
12	2	As mapped.	Yattalunga seawall should be a priority for construction. Plan of Management (GCC, 1995) identifies the issue with funding approved. Suggest "Use your brain" program reinvigorated. Improved stormwater management through implementation of PoM - additional location at Green Point.	L
13	2	As mapped.	Culvert at Tascott Station has water quality issues - low rates of flushing cause odours and amenity issues. Sediment and pollution problems.	L
14	2	As mapped.	Safety issue with boat users not observing speed limits and causing increased wave action, leading to damage and safety issues. Anecdotal observation of man in water carrying out boat maintenance a risk of crush against a structure from boat wave action. Request reduced speed limit to allow equity of access and safety.	H
15	2	As mapped.	Floating pontoons to be installed at boat ramps instead of fixed height jetties.	L
16	4	As mapped.	Unsafe navigation due to sediment build-up. Observed reduction in velocity of currents in major navigation channels.	M
17	2	As mapped.	Sailing Club and Brisbane Water Rowing Club have conflicts in key training locations with ski boat users causing safety issues. Boat storage problems near foreshore.	M
18	2	As mapped.	Pollution and stormwater runoff problem; increase in seagrass. Also, Policy of rock walling restricts user-friendly access to water. Gosford is the last venue suitable for regattas.	M
19	2	As mapped.	Management issue regarding location and number of moorings. Improved policy and guidelines on number and location of moorings.	M
20	2	As mapped.	Noise from PWC and other boats, speeding vessels, mosquitoes and water quality issues associated with stormwater discharge.	L
21	3	As mapped.	Sedimentation and poor flushing of water.	M
22	3	As mapped.	Sedimentation - sediment traps required.	M

Issue No.	Zone	Location	Management Issue	Ranking
23	4	As mapped.	Sedimentation and foreshore erosion.	M
24	4	As mapped.	Sedimentation and low water level. Woy Woy Creek and the creek from the Everglades are the main sources.	M
25	3	As mapped.	Sedimentation needs removal and clean up. Plants and trees growing in the water.	L
26	3	As mapped.	Boat wake and speed limits exceeded.	H
27	3	As mapped.	Siltation and issues relating to boat access via channel.	L
28	4	As mapped.	Unlit channel markers. Slime over seagrass in winter.	M
29A	4	As mapped.	29A-F. Canals off St Hubert's Island in need of urgent maintenance to return to original design criteria. Also channels leading to the Island silting up.	L
29B	4	As mapped.	See above.	L
29C	4	As mapped.	See above.	L
29D	4	As mapped.	See above.	L
29E	4	As mapped.	See above.	L
29F	4	As mapped.	See above.	L
30	3	As mapped.	Sedimentation traps are not being maintained. Need additional traps upstream of the Bay.	M
31	3	As mapped.	The amount of sediment flowing out in heavy rains goes way past Horsfield Road point. Correa Bay sand bar needs a pole or other navigational marker. Boats approaching boat ramp come in at high speed and go around moored boats, hitting and extending the sand bar on the lower side of the tide.	M
32	4	As mapped.	Sediment build-up has almost blocked the channel. The entrances to St Hubert's Island canals are almost closed to navigation. Disappearance of aquatic vegetation in the channels.	L
33	3	As mapped.	Waterfall Bay: conflict between skiers using PWC and larger boats used by families who may sleep overnight. Ski boats ride around family boats wake and skiers take off from the sand bar.	L
34A	4	As mapped.	Boat wash from large vessels. Compacted soils from vehicles prevent regrowth of saltmarsh and mangroves.	H
34B	4	As mapped.	See above.	H
34C	4	As mapped.	See above.	H
35	3	As mapped.	Need to increase height of the bridge.	L
36	3	As mapped.	Unmarked rocky outcrop.	M
37	3	As mapped.	Needs a culvert under Brisbane Water Dr and the railway line to flush Woy Woy Bay and stop the increased water level.	M
38	2	As mapped.	Sand accumulation at the entrance prevents tidal interchange in the estuary. Velocity of currents in major channels is decreasing. Natural scouring to maintain depths is not occurring. Sand build-up is occurring in all the major channels. Dredging at the entrance is necessary.	M
39	4	As mapped.	Foreshore erosion at Illoura Reserve, Davistown, at the end of Pyang Ave.	M
40	6	As mapped.	Siltation of channel causing navigational hazard.	M
41	4	As mapped.	St Hubert's Island overall (assumed to refer to the need to address navigability issues associated with the canals).	M
42	4	As mapped.	Sedimentation problem. Pelican Island has trebled in size (at low tide) over the past 2 years. Jetties are unusable at times other than high tide. Health hazard from mosquitoes.	L
43	3	As mapped.	Every time it rains a lot of clay comes down Dead Man's Creek (aka Woy Woy Creek).	L
44	4	As mapped.	Four knot zone not observed, leading to erosion of the foreshore, damage to moored vessels and structures, and compromises the safety of other waterway users. Navigation markers need updating/moving to reduce confusion and help highlight no wash zone. No sedimentation traps on concrete drains.	M
45	5	As mapped.	Actually a massive weed bed. Shoaling up - needs dredging.	M
46	5	As mapped.	Sailing boats with drop/fixed keel cannot access the Broadwater.	
47	5	As mapped.	Medium to large sized craft (1m draught) cannot get in at half tide.	M

Issue No.	Zone	Location	Management Issue	Ranking
			Bay has filled up over the last couple of years. The ferries that previously ran here kept it open.	
48	4	As mapped.	Merrit's Wharf: seagrass dragged in by trawlers has been washing ashore.	L
49	5	As mapped.	Weeds have been present in wetland area for 20 years; Lantana, Blackberry, Privet, Asparagus Fern. Loss of fauna due to cats. Fauna sighted incl. Echidna and Bandicoots. These fauna need protection. Also, need to prevent flooding in residential areas.	H
50	4	As mapped.	Valuable flood zone.	L
51	5	As mapped.	Unique flora and fauna needs to be maintained.	H
52	5	As mapped.	Poor navigation markers, not easily visible. A lot of vessels being damaged and running aground.	L
53	5	As mapped.	Inadequate drainage leading to an alluvial fan. Increased sedimentation and only one sediment trap.	M
54	4	As mapped.	Rubbish getting washed in and caught up in mangroves.	M
55	5	As mapped.	No large fish, only small ones. Loss of seagrass.	M
56	5	As mapped.	Oyster leases, can only get in at low tide.	L
57	5	As mapped.	Meadow Creek is all silted up. Acid Sulfate Soils present.	L
58	5	As mapped.	Silting up again.	M
59	5	As mapped.	Overflow from septic tanks at times.	L
60	4	As mapped.	Bar mouths need dredging.	M
61	5	As mapped.	Lack of navigation lights at night, all the way from Linton Channel up to the Broadwater.	L
62	5	As mapped.	Seagrass getting torn up by vessels in the navigation channel.	M
63A	5	As mapped.	Saltwater coming out of the drain. Sewer overflows into the creek draining to Empire Bay.	L
63B	5	As mapped.	See above.	L
64	5	As mapped.	Turbidity issues.	M
65A	5	As mapped.	Only four boat entry points - need for greater access and dedicated parking.	L
65B	5	As mapped.	See above.	L
65C	5	As mapped.	See above.	L
65D	5	As mapped.	See above.	L
66	5	As mapped.	Potential stormwater retention site. One large drain drains to Empire Bay.	L
67	5	As mapped.	Main issue is egress of fresh water into the estuary - turbidity, sediment and water quality.	L
68	5	As mapped.	Decline in large cockles and pippies. Hatching area no longer functioning.	H
69A	5	As mapped.	Noisy water skiers early in the morning.	L
69B	5	As mapped.	See above.	L
70	5	As mapped.	No boating facilities except for one or two (e.g. Empire Bay Marina). Need for re-fuelling, hard-stand maintenance area, slipways, boating hardware and pump out areas. People are currently dumping sewage.	H
71	5	As mapped.	Swamp mahogany trees need to be protected.	H
72	6	As mapped.	Oyster leases that appear to not be in use at present - should they be removed? They encourage siltation e.g. around the jetty. Better usage of this area for recreational rather than commercial purposes. Boat users vessels are being moved to other sites resulting in loss of revenue. Blockage of entrance and sediment accretion.	M
73	6	As mapped.	New mangroves associated with stormwater outlets; capture sediments/rubbish/wrack and overtaking seagrass. Ferry operations probably causing seagrass loss. Conflict between residents and the existing marina - marina expansion said to impinge on seagrass and impact on parking and dinghy storage. Loss of Posidonia seagrass (due to sedimentation?). High turbidity after storm events and lack of flushing. Lack of silt control on the escarpment. Progradation of mud flat.	H

Issue No.	Zone	Location	Management Issue	Ranking
74	6	As mapped.	Siltation related to creek and stormwater outlet.	M
75	6	As mapped.	Channel inadequate - have to wait for ferries to come in. Problem with SE swell. Impact on race days / regattas. Issue primarily over last 18 months.	L
76	6	As mapped.	Issue with navigation, especially during bigger swell. Quite strong currents there as well. Boat waves from larger craft impact on smaller craft. Channel narrowing at Half Tide Rocks. No speed restrictions here.	L
77	6	As mapped.	Mangroves inhibiting flow of creek and encouraging sedimentation.	L
78A	6	As mapped.	Dumping of sand on Ettalong Beach caused by blocking of entrance channel. Beach used to be longer. Issue regarding rock placement and access. Suggest shoreline protection or seawall at this location.	M
78B	6	As mapped.	See above.	M
79	6	As mapped.	Mounds of sediment left by those harvesting nippers at this location contributing to sedimentation. Rubbish accumulates, especially after big winds. Education required and boat users need facilities.	M
80	6	As mapped.	Shoaling of entrance affecting tidal exchange in the estuary? Need for dredging to encourage tourism and boating.	M
81	4	As mapped.	Confusing at the moment. Four knot zone is located too far away for people to see. Needs to be moved for clarity.	L
82	6	As mapped.	Cardinal marker has been damaged - yachts run aground. Also unlit markers at night. Particularly a problem for visitors.	L
83A	4	As mapped.	Sedimentation and pollution associated with stormwater drains. Seagrass wrack concentrating in this zone. Local water quality issues and rubbish. Damage to boats. Sewage overflows and leaks. Wash also an issue for smaller boats.	M
83B	4	As mapped.	See above.	M
84	6	As mapped.	Ferry cuts across sand banks rather than going via the channel - impact on sedimentary processes, changing the hole at this location.	M
85	6	As mapped.	Safety issues for navigation, erosion and damage to moored boats. Wash also an issue for small boats.	M
86	6	As mapped.	Access to wharf difficult.	L
87	6	As mapped.	Very dangerous spot due to presence of oyster and pearl leases.	L
88	6	As mapped.	Oysters continue to require depuration despite presence of sewage pump out. This has implications for revenue. Issues with boats having adequate capacity for holding sewage - need greater education about the presence of this pump out facility.	M
89	-		Fees paid to state government for use of waterways need to go to implementation of the management plan when it's developed.	M
90	-		Observation of change in ecology with increase in human population.	H
91	-		Seagrass issues and potential loss of marine biodiversity.	H
92	-		Concerns about climate change impact.	H
93	-		Need to increase boating facilities and associated foreshore infrastructure.	M
94	-		Pollution from boats is minimal.	L
95	-		Moored boats - copper-based antifouling leads to sediment contamination and also prevents the growth of seagrasses especially as they occur in shallows (problem is enhanced by increased abundance of shallow areas related to sedimentation for locations such as Hardy's Bay and Pretty Beach).	M
96	-		Sedimentary contamination - boat cleaning contributing to contamination.	M
97	-		Swing moorings allocated but boats not used. Potential sources of contamination.	L
98	6		Loss of shellfish in Hardy's Bay in recent years.	M

Issue No.	Zone	Location	Management Issue	Ranking
99	-		Lack of large fish - impact on fishing charters over 20 years has been a problem. Declines in fish numbers have resulted in increases in fishing pressure for both shore and water based fishers.	M
100	-		General lack of fish in the area.	M
101	-		Dolphins used to be sighted more regularly than they are now.	L
102	-		Pretty Beach baths in wrong location. Flow impeded by mangroves and wharf.	L
103	-		Shift in ecology - different seagrass, different growth on boats and changes to fish populations.	M
104	-		Issue regarding ballast - introduced species. Previously there were barnacles, now there is generally an orange sponge-like growth.	M
105	-		Potential pollution related to roadways.	L
106	-		Navigation issue in entrance is increasingly bad. Used to be two way channel.	H
107	-		Ongoing issue with septic systems overflowing in wet weather.	L
108	-		No kerb and gutter - increased sediments into the waterways. Alluvial deposits associated with stormwater drains. Need for catchment based controls and stormwater is bypassing natural wetland filters.	M
109	-		Enforcement of construction and operational erosion and sedimentation controls and related council policy.	H
110	-		Important to conserve the existing wetlands and riparian vegetation.	H
111	-		Epiphytes on seagrass didn't used to be there - damage to seagrass. Concerns regarding loss of communities associated with seagrass and the effect on fishing. Number and diversity of fish associated with seagrass. Caused by high nutrient loads encouraging epiphytic growth.	L
112	-		Flushing problems especially after storm events.	M
113	-		Not many cockles and shellfish, and no large ones due to overharvesting. May be overarching issues of habitat loss and general ecological changes.	L
114	-		Uncontrolled activity on foreshore such as the proliferation of jetties.	H
115	-		Acid Sulfate Soils are a potential problem when flushing is impeded.	L
116	-		Swing moorings remove aquatic vegetation and increase turbidity, which means decreased light penetration and loss of seagrass.	L
117	-		Poor water quality.	H
118	-		Impact of flood mitigation works on wetlands.	M
119	-	All; especially Narara and Erina Creek catchments	Increasing/uncontrolled development of the catchment resulting in changes to catchment hydraulics and impacting on water quality.	H
120	-	Kincumber, Cockle Bay	Stormwater/sewer/septic overflows impact on water quality.	L
121	-		Soil erosion in the catchment.	M
122	-		Loss of riparian vegetation.	H
123	5	Cockle Bay	Impacts on tidal prism in relation to human activity.	M
124	6	Ettalong Shoals	Impacts on tidal prism in relation to shoal propagation / siltation of waterways.	M
125	1	Fagan's Bay	Low rates of flushing in the upper estuary.	M
126	6	St Hubert's Island	Foreshore inundation; flooding.	M
127	-	All; esp. St Hubert's Island	High levels of sediment re-suspension in intertidal areas, around oyster leases and around St Hubert's Island.	M
128	-		Impacts of projected sea level rise on foreshore infrastructure.	H
129	4, 5, 6	Ettalong Shoals, Paddy's Channel, N of Pelican Island, Cockle Channel, Saratoga	Impacts of shoal propagation on navigability of waterways.	M

Issue No.	Zone	Location	Management Issue	Ranking
130	-	Hardy's Bay, Woy Woy, Fagan's Bay, Gosford Harbour, Kincumber Creek, St Hubert's Island	Siltation of waterways.	M
131	-		Poor sediment quality, particularly in the upper estuary; associated with antifoulants and stormwater outlets.	M
132	-	Cockle Bay	Occurrence of Potential and Actual Acid Sulfate Soils.	L
133	-	St Hubert's Island, Ettalong and Point Clare	Disruption to natural shoreline processes by artificial structures (e.g. seawalls, jetties, wharves and boat ramps).	M
134	-	Yattalunga, Ettalong Beach, N of Blackwall Pt, Davistown	Shoreline erosion / recession.	H
135	-	Hardy's Bay, Cockle Bay, Woy Woy, Horsfield Bay	Erosion and/or sedimentation associated with stormwater outlets.	M
136	2	Gosford 1st Sea Scouts	Seawall collapse.	L
137	-		Poor water quality, esp. after rainfall.	H
138	6	Hardy's Bay	Impacts of high suspended sediment loads on primary productivity.	M
139	3, 5	Fagan's Bay, Woy Woy Bay (Brisbane Water Drive), Cockle Bay, Kincumber Broadwater, Tascott (culvert).	Low rates of estuarine flushing.	M
140	-		Poor water quality associated with stormwater outlets.	M
141	3, 4	Woy Woy, Ettalong	Water quality impacts due to leachates from garbage tip.	L
142	-		Loss of biodiversity and need for environmental protection - Pelican Island, Swamp mahoganies need protection in Cockle Bay Nature Reserve.	H
143	-		Loss and degradation of natural foreshore vegetation in association with foreshore structures.	H
144	-		Degradation of seagrass beds.	H
145	2, 3, 6	Pelican Island, Caroline Bay, Hardy's Bay, Woy Woy	Change (often loss, but increase in some cases) in extent of seagrass habitats.	H
146	5, 6	Cockle Channel, Ettalong	Loss of seagrass due to boating activity (scour).	H
147	6		Loss of aquatic vegetation due to swing moorings.	H
148	2, 6	Noonan Point, St Hubert's Island	Accumulation of seagrass wrack.	L
149	4	Empire Bay	Reclamation of tidal wetlands.	M
150	4	Empire Bay	Restricted tidal inundation of wetlands due to human constructs.	M
151	5, 6	St Hubert's Island, Cockle Bay	Anthropogenic disturbance of estuarine flora habitats and fauna.	M
152	6	Hardy's Bay	(Suspected) increase in the extent of mangroves at the expense of saltmarsh/seagrass.	H
153	1, 6	Fagan's Bay, Hardy's Bay	Progradation of mangroves near tributaries.	M
154	1	Fagan's Bay	Algal infestation.	M
155	4	Davistown	Compaction of soils due to vehicles and associated loss of intertidal vegetation.	L
156	-		Introduction of pest species (both flora and fauna). Fouling species; weeds (Cockle Bay wetlands); cats.	M
157	-		Presence of mosquitoes.	L
158	6	Pretty Beach	Overharvesting of shellfish and beach worms, leading to declines in size/number.	H
159	-		Decline in fish numbers and size ranges.	M
160	-		Declines in the number of birds visiting the estuary.	M
161	-		Observations of dead birds (pelicans and ducks).	L
162	2, 3	The Broadwater, Ettalong, Lobster Beach, Hardy's Bay, Waterfall Bay	Conflicts between different user groups, particularly between passive and active recreational users.	H
163	5	Kincumber Broadwater (water skiers), Woy Woy	Disturbance of the peace (primarily relating to powered water craft).	M

Issue No.	Zone	Location	Management Issue	Ranking
		(boats)		
164	-		Need for integrated approach to planning for the estuary and surrounds.	H
165	-		Lack of public access to parts of the estuarine foreshore.	M
166	-		Inadequate recreational amenities, particularly walking tracks/pathways, BBQs and toilets.	M
167	-		Poorly planned foot and cycle paths that lack connectivity, go no-where or are unsafe.	M
168	-		Inadequate facilities for swimming (i.e. enclosures).	L
169	6		Public safety on the waterway.	H
170	6	Cockle Bay, Ettalong, Woy Woy, etc.	Navigational hazards - poor identification of navigation channels, etc.	M
171	2, 3	The Broadwater, Half Tide Rocks, Woy Woy	Waterway traffic exceeding speed limits / excessive boat wakes.	H
172	6	Hardy's Bay	Public safety associated with high usage of boat ramps and commuter ferry wharves.	M
173	2	The Broadwater	Scour and/or foreshore erosion due to boat wake.	M
174	6		Inappropriate storage of dinghies and other watercraft.	M
175	2	The Broadwater	Inadequate storage facilities for dinghies and other watercraft	M
176	-		Not enough moorings.	M
177	-		Inadequate boating facilities generally.	M
178	2, 5	Saratoga, Green Point, Davistown	Sediment accretion near boat ramps and loss of access.	M
179	2, 6	Gosford, Hardy's Bay	Public boat ramp inadequate to service existing use.	M
180	-		Illegal and undesignated launching of boats.	M
181	-		Insufficient provision for car and trailer parking.	M
182	-		Inadequate lighting of boat ramps and car parks.	M
183	2	Tascott	Seawalls and other foreshore structures prevent access to the water for users of small craft (e.g. rowing clubs)	M
184	-		Overdevelopment of the Brisbane Water foreshores.	H
185	-		Commercial and tourism potential of the estuary not fully realised.	M
186	-	Caroline Bay, Hardy's Bay, Pretty Beach, St Hubert's Island	Littering	M
187	6	Hardy's Bay	Oyster leases not in use but left in place (need decommissioning).	L
188	-		Oyster leases untidy and poorly maintained.	M
189	-		Lack of awareness amongst boaters re: sewage pump out requirements and facilities.	H
190	2	Empire Bay	Poor drainage for some roads.	L
191	2, 6	Hardy's Bay, Koolewong, Tascott	Unpleasant odours associated with stormwater outlets, mud flats and/or seagrass wrack.	M
192	6	Ettalong Shoals	Presence of shipwrecks makes dredging difficult.	M
193	-		Behavioural problems associated with off-leash dogs.	L
194	4	Bensville Wharf	Dumping of fuel by helicopters	L
195	1	Upstream of Ann Close Reserve (off Manns Road)	Bank erosion along Narara Creek.	M
196	2	Between Ironbark Point and Rocky Point, Green Point	Narrow stretch of reserve restricts public access.	L
197	2	Green Point	Orana Street boat ramp only accessible at high tide.	L
198	2	Green Point	Foreshore erosion; degradation of foreshore vegetation through mowing to the water's edge.	M
199	2	Dane Drive, Gosford	Floating booms currently in place to capture rubbish from the stormwater outlets need addressing.	M
200	2	Dane Drive, Gosford	The existing seawall does not function to dissipate wave energy, with breaking waves affecting the foreshore resulting in increased salinity, vegetation die-back and erosion.	M
201	2	Dane Drive, Gosford	Scouring is occurring behind the seawall.	M
202	2	Dane Drive and Mason Parade, Gosford	Accumulation of seagrass wrack along the beach in front of the Sailing Club.	L
203	2	Brisbane Water Drive,	Accumulation of seaweed, wave attack and siltation along the	L

Issue No.	Zone	Location	Management Issue	Ranking
		Tascott and Point Clare	foreshore.	
204	2	Punt Bridge, Central Coast Highway	Boat ramp has poor access due to lack of parking.	L
205	2	Punt Bridge area, Central Coast Highway	Erosion and loss of vegetation.	M
206	2	Masons Parade, Gosford	Dinghies currently being stored in an Endangered Ecological Community adjacent to the Scout Hall.	H
207	2	Muloora Road, Springfield	Subsidence into Erina Creek is occurring.	M
208	3	Correa Bay and Horsfield Bay.	Weeds present.	M
209	-		Encroachment on reserves by public residents.	H
210	3	Goondi Close, Horsfield Bay	Foreshore erosion.	M
211	3	Railway Street, Woy Woy	Mangroves are impeding flow out of the stormwater outlets near the train station.	M
212	3	Woy Woy	Foreshore access impeded by rail line.	L
213	3	Parks Bay	Erosion is occurring under the bridge near Lara Street.	L
214	4	Brick Wharf Road, Woy Woy	Stormwater outlets located in the Lions Memorial Park are obstructed by weeds and also get inundated under some conditions.	M
215	4	Brick Wharf Road, Woy Woy	A large amount of weeds have built up around the boat ramp in Lions Memorial Park.	L
216	4	Brick Wharf Road, Woy Woy	The seawall located in Lions Memorial Park is collapsing. It is noted that this seawall has been repaired a number of times in the last 30 years.	M
217	4	Austin Butler Access, Woy Woy	The main stormwater drain between the two ovals has collapsed and is accreting sediments.	L
218	4	Saratoga, Davistown and Empire Bay	Damage to saltmarsh.	H
219	4	Blackwall	Stormwater runoff from fire trails located in Blackwall Mountain is causing water quality issues.	M
220	4	Daleys Point	Loss of reserve due to foreshore erosion in Palermo Reserve on Empire Bay Drive.	M
221	4	Blackwall	Substantial erosion is occurring near the Blackwall Point boat ramp and is affecting the road.	M
222	6	Fisherman's Parade, Daleys Point	Stormwater runoff from the dirt access road and fire trail is causing water quality issues.	M
223	5	Davistown	Scouring is occurring behind the seawall in Illoura Reserve. In addition, the design permits vandalism and other tampering, thereby exacerbating the erosion.	M
224	4	Blackwall	Shoreline erosion is occurring at the Rip Road Reserve.	M
225	5	Davistown	Shoreline erosion is occurring near from Lintern Street to 28 Malinya Road in Illoura Reserve.	M
226	4	Saratoga	Poor access via the waterway to the Centennial Street boat ramp.	L
227	4	Woy Woy	Degradation of the tidal baths near Brisbane Water Drive.	L
228	5	Cockle Bay	Erosion and siltation.	M
229	4	Saratoga	Drainage issues are impacting on recreational usage of the oval near Willaroo Road.	L
230	5	Kincumber	Poor access for bikes and pedestrians near Carrak Road.	L
231	5	Kincumber	Regionally significant vegetation located in the reserve near Carrak Road is subject to vandalism.	H
232	5	Davistown	Provide protection of the Green and Golden Bell Frog and Bush Stone Curlew.	H
233	4	Paddy's Channel	Siltation.	M
234	5	Hawke Street, Kincumber	Unsealed car parks are eroding into Kincumber Creek.	M
235	5	Hawke Street, Kincumber	Disused boat trailer and floating pontoon still in place.	L
236	2	Mundoora Avenue, Yattalunga	Drainage from private residences is being directed onto the public reserve.	L
237	5	Kincumber	There is difficulty cleaning stormwater pipes in the region of Hawke Street due to pollution originating from the industrial area.	M

Issue No.	Zone	Location	Management Issue	Ranking
238	2	Saratoga	Potential for erosion from the sloping lands draining to the stormwater outlet opposite Byalla Lane.	L
239	2	Saratoga	Scour associated with high velocity stormwater flows from the outlet near the corner of Jirramba and Mimosa Avenues.	L
240	2	Yattalunga	Poor drainage and flow in the open drain near Mundoora Avenue to low invert.	L
241	2	Yattalunga	Siltation is occurring in the open drain located on the foreshore between Mundoora Access and Wilkie King Avenue.	M
242	2	Green Point	Siltation in the creek is exacerbating flooding over the road near Avoca Drive and Sun Valley Drive.	M
243	2	Green Point	Bank erosion of the creek running to the north of Sun Valley Drive in the region of Avoca Drive.	M
244	6	Hardy's Bay	Erosion of the seawall along the southern shore in Hardy's Bay.	M
245	6	Ettalong	Build up of litter in the open drain near Beach Street.	L
246	6	Killcare	Erosion and collapse of trees into the water along Hardy's Bay Parade.	M
247	6	Ettalong	Lance Webb Reserve is subject to erosion, thought to be attributable to wash from ferry. In addition, access to the reserve and beach is limited.	M
248	-		Residents of land adjacent to foreshore reserves may often encroach on public reserves and undertake maintenance.	H
249	-		There is a lack of opportunity for Bushcare groups due to a lack of resources for their management within Council.	H
250	-		The promotion of Brisbane Water as a tourist destination is generally lacking. There is a lack of information about scenic drives and available facilities. Interpretive signage is also lacking.	H
251	-		Vandalism of trees is an ongoing issue for vegetation management and foreshore erosion.	L
252	-		There is a need for improved coordination of project implementation, asset management and sourcing of funding within Council.	H

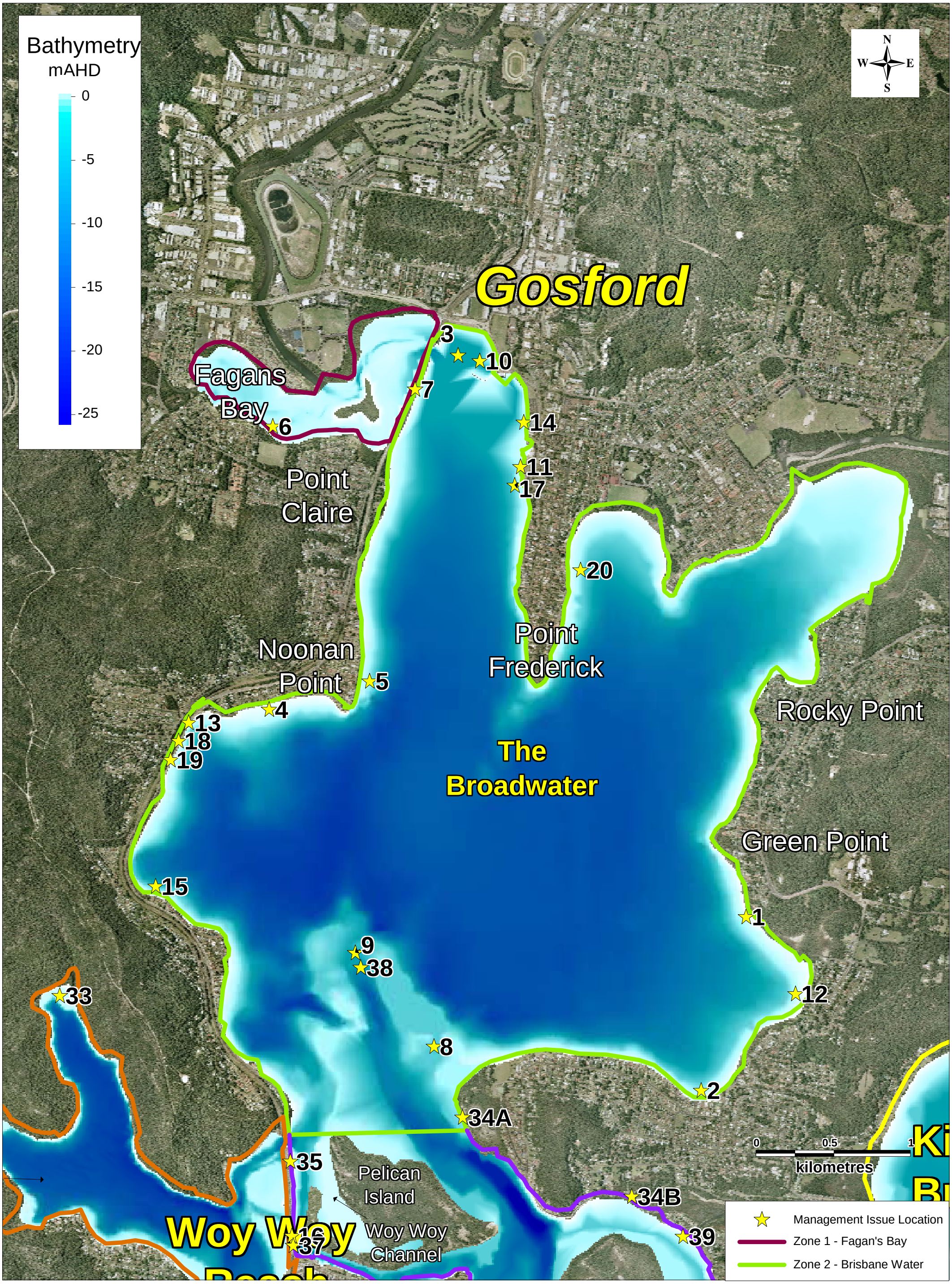

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FIGURE D1
MANAGEMENT ISSUES
ZONES 1 AND 2

LJ2717/R2471/V1
October 2009

LJ2717/Appendices/Appendix D/Figure D1.wor

Woy Woy Bay

Woy Woy Reach

Pelican Island

Woy Woy Channel

Rileys Island

Woy Woy Inlet

St Hubert Island

Blackwall Point

Cockle Chan

Bathymetry
mAHD
0
-5
-10
-15
-20
-25

Management Issue Location
Zone 3 - Woy Woy Reach
Zone 4 - Central Reach

0 0.5 1
kilometres

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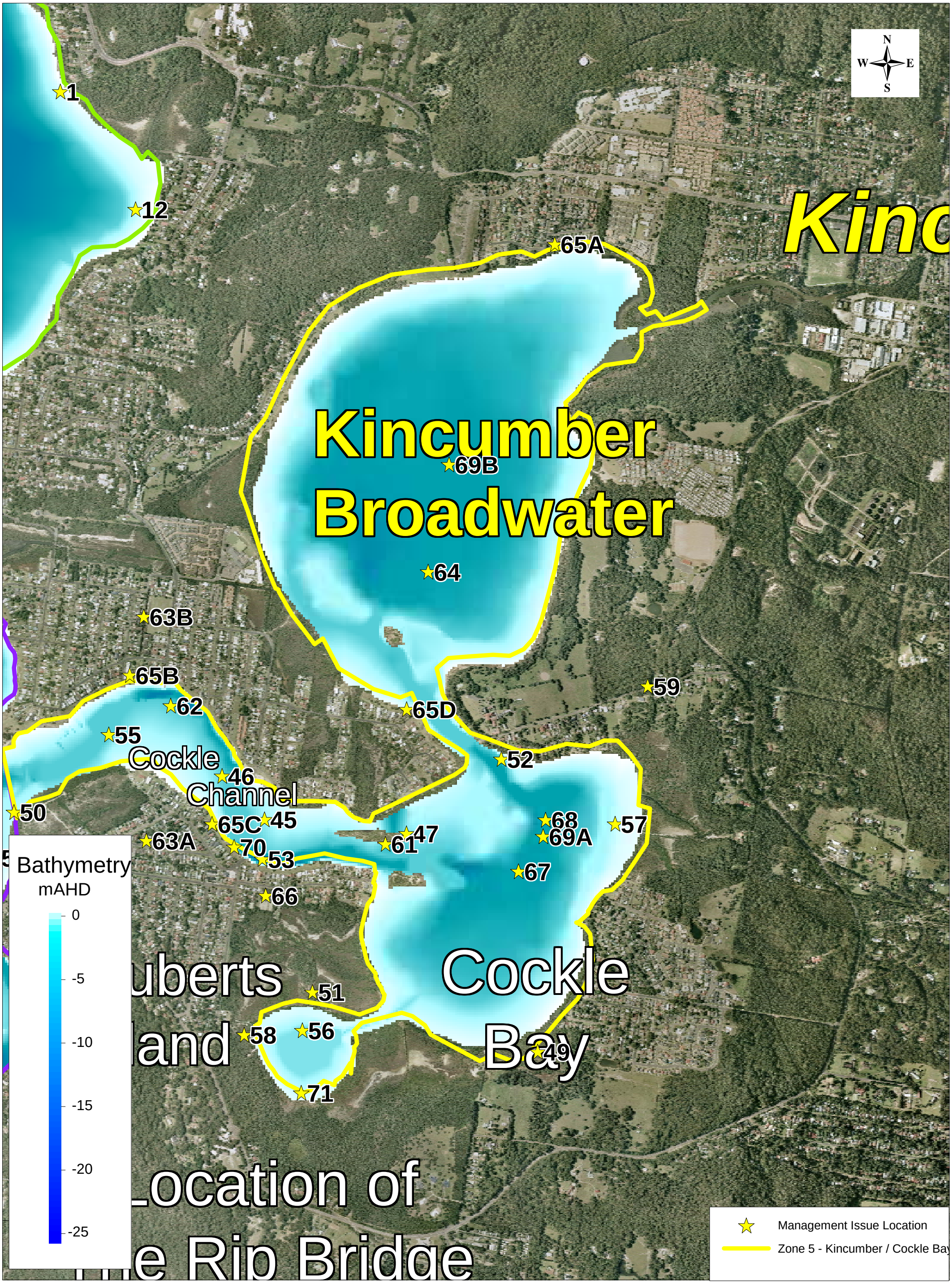

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FIGURE D3
MANAGEMENT ISSUES
ZONE 5

LJ2717/R2471/V1
October 2009

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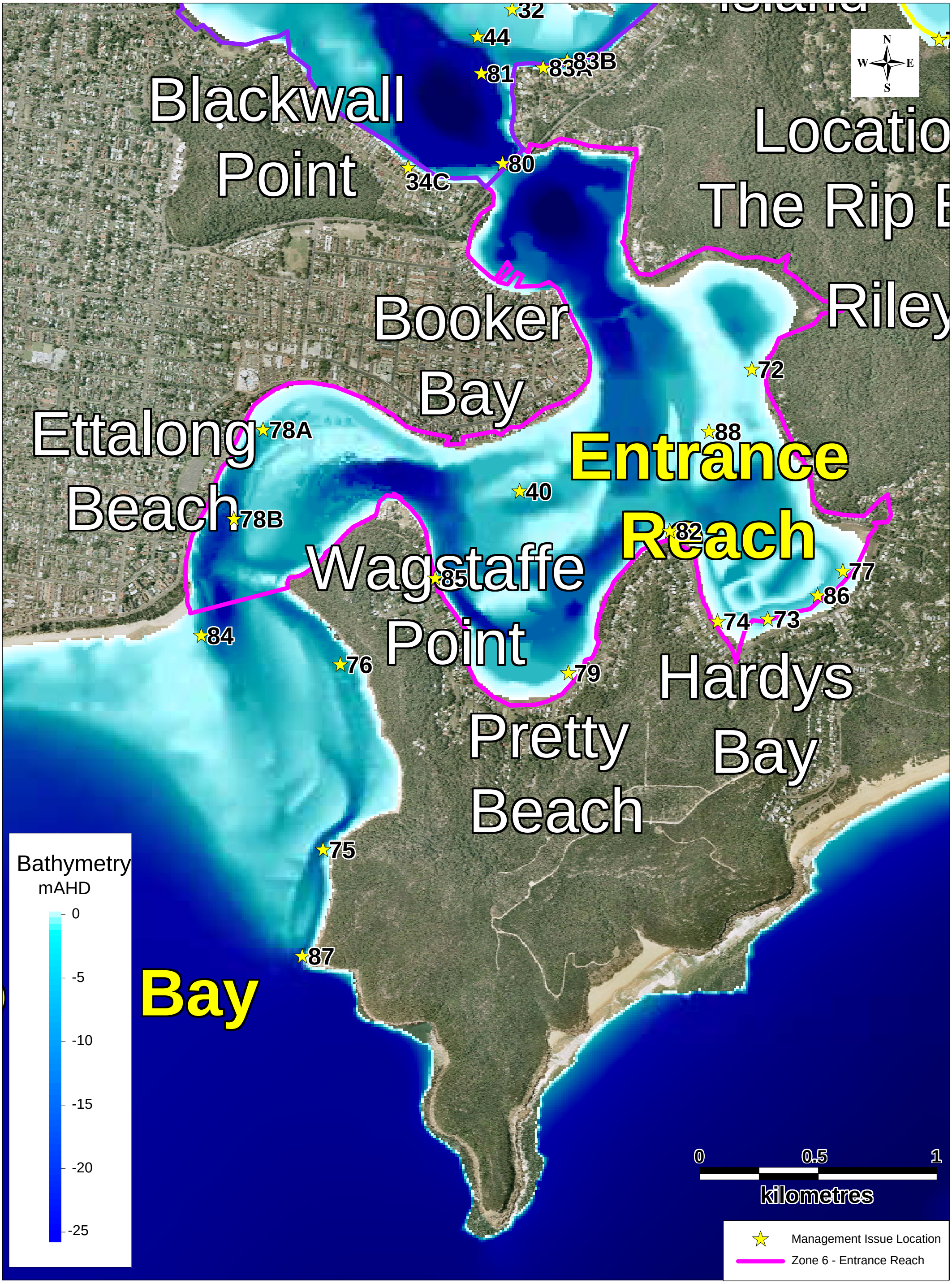

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FIGURE D4
MANAGEMENT ISSUES
ZONE 6

LJ2717/R2471/V1
October 2009

LJ2717/Appendices/Appendix D/Figure D4.wor

Appendix E

Management Options – Unranked

Option ID	Management Goal Addressed	Management Category	Strategy Outline	Location	Zone	Primary Responsibility	Secondary Responsibility	Cross Reference with Option:	Dependency on Option:	Preliminary Indicative Estimate of Capital Cost	Preliminary Indicative Estimate of Annual Maintenance/ Recurrent Cost/ Revenue (-ve values)	Net Present Value	Potential Funding Stream	Water & Sediment Quality	Sedimentary Processes	Ecological Processes	Foreshore Flooding / Inundation	Cultural Heritage	Visual Amenity	Recreational Usage	Development	Governance	Information, Communications and Education	Raw Benefit Index	Council / DECCW Response	Community Response	Adjusted Benefit Index
P57	Commercial Development	Planning	Use the findings of the Brisbane Water Estuary Processes Study to inform the masterplanning process for the Gosford city centre.	Gosford	2	GCC	DoP	P56		Gosford City Challenge		N/A		1	1	2	2	3	3	3	3	0	3	21	2		24
P53	Commercial Development	Planning	Promote the Brisbane Water Estuary for eco-tourism and support relevant local commercial development in this area.	Estuary Foreshores/Waterway-wide	All	GCC	LPMA, Central Coast Tourism, Gosford Chamber of Commerce	P22, P38, P54, P55,	P54	$ 300,000	$ 100,000	$ 1,359,401		0	0	5	0	4	2	5	5	0	0	21	1		22.5
P54	Commercial Development	Planning	Promote the sustainable commercial development of the Estuary and its foreshores in accordance with Council's Corporate Strategy and the principles of Ecologically Sustainable Development.	Catchment-wide/Waterway-wide	All	GCC	LPMA	P53, P55, P56, P57		$ -	$ 55,000	$ 582,671		-1	-1	4	-1	4	3	4	5	0	0	17	2		20
P56	Commercial Development	Planning	Develop a strategy to promote and enhance the connection between the Gosford city centre and the Brisbane Water Estuary.	Gosford	2	GCC	DoP	P57		Gosford City Challenge		N/A		0	0	0	0	5	3	5	3	0	2	18	1		19.5
P55	Commercial Development	Planning	Investigate options for constructing new (and/or expanding existing) boating facilities.	Waterway-wide	All	LPMA, Private Developers	GCC	P54	R32	$ 100,000	$ -	$ 100,000		-2	-2	-1	0	0	-1	4	4	0	0	2	0		2
P31	Cultural Heritage	Planning	Provide ongoing protection for sites of significance for local Aboriginal people.	LGA-wide	All	DECCW	GCC	P29	WP28, W34	$ -	$ 45,000	$ 476,731		0	0	0	2	5	1	0	0	0	0	8	2		11
R27	Cultural Heritage	Research/Monitoring	Identify the likely location and condition of ship wrecks near the old bar via a maritime archaeological survey.	Entrance	6	DoP	LPMA	W18		$ 80,000	$ -	$ 80,000		0	2	0	0	5	0	1	0	0	0	8	2		11
R28	Cultural Heritage	Research/Monitoring	Assess the potential impacts of climate change on heritage items located around the Estuary and along its foreshores.	Waterway-wide/Catchment-wide	All	DoP	GCC	R28	P43	$ 50,000	$ -	$ 50,000	NSW DoP Heritage Grant	0	0	0	3	5	1	0	0	0	0	9	1		10.5
R29	Cultural Heritage	Research/Monitoring	Recognise the historic Aboriginal ownership and use of the area by undertaking research into local languages, customs and significant sites.	LGA-wide	All	GCC	DECCW	P31		$ 100,000	$ -	$ 100,000	DEWHA Indigenous Heritage Program (up to $100,000)	0	0	0	0	5	0	0	0	0	0	5	2		8
C13	Foreshore Development	Compliance	Provide additional resources for enforcement of compliance with foreshore development controls.	LGA-wide	All	GCC		C02, C14		$ -	$ 75,000	$ 794,551		2	3	3	3	1	1	0	0	0	2	15	1		16.5
C14	Foreshore Development	Compliance	Audit existing foreshore development (including property boundaries, fences and other structures, boat houses, boat ramps, jetties, etc.) and identify illegal or non-conforming development for retrospective enforcement of development controls. This should be undertaken in accordance with the Conditions of Consent and relevant policy in force at the time of Development Approval.	Estuary Foreshores	All	LPMA	GCC	C02, C13, P10, P11, P14, P44, P51, P52	R31	$ 90,000	$ -	$ 90,000		1	3	1	2	1	1	0	0	0	2	11	1		12.5
P43	Foreshore Development	Planning	Prepare a *Sea Level Rise Study* that will deliver land use zoning and development controls for the Estuary that are based on the current IPCC projections of 0.91m sea level rise by 2100. The preparation of this study should be closely linked to the *Brisbane Water Foreshore Flood Plain Risk Management Study & Plan*, anticipated to be drafted by 2011.	Estuary Foreshores	All	GCC	DECCW	P10, P15, P44, P45, P51, P52, P54		$ 45,000	$ -	$ 45,000		0	3	2	5	4	0	-1	3	0	5	21	2		24
P45	Foreshore Development	Planning	Undertake a review of the existing foreshore development policies and plans for the Gosford LGA and assess the need to amend development controls to provide for controlled, sustainable development of the foreshore.	LGA-wide	All	GCC		P08, P09, P10, P29, P30, P54 , W82	P43	$ 60,000	$ -	$ 60,000		1	4	3	4	1	3	0	-2	0	0	14	1		15.5
P49	Foreshore Development	Planning	Develop guidelines (or compile existing guidelines where available) for foreshore stabilisation via the establishment of locally native estuarine plant species. The guidelines should provide details of the benefits of soft stabilisation works, advice on the species to be used and how to establish plantings. Seedlings may be cultivated at Council's nursery for supply to interested parties.	LGA-wide	All	GCC	CMA, DECCW	W34, W41, W42, W45, W48, W49, W104		$ 30,000	$ 50,000	$ 559,701		2	5	4	2	0	0	0	0	0	2	15	0		15
P50	Foreshore Development	Planning	Review *D6.47 - Setback Policy: Creeks, Rivers and Lagoons* . The review should in the first instance widen the definition of applicable waterbodies to incorporate 'estuaries', and in the second instance be re-assessed to incorporate the likely impacts of climate change. In particular, the setbacks applied should be re-assessed to take into account processes relating to both catchment flooding and foreshore inundation.	LGA-wide	All	GCC		P44	P43	$ 15,000	$ -	$ 15,000		0	4	3	5	0	0	0	0	0	0	12	2		15
P48	Foreshore Development	Planning	Develop environmentally friendly design and construction guidelines for foreshore infrastructure such as jetties, boat ramps and foreshore protection works. This should include advice on retro-fitting existing structures to be more environmentally friendly. The guidelines should be made publicly available and distributed to all foreshore property owners. (Note: Seawalls addressed in DECCW's *Environmentally Friendly Seawalls Guidelines*).	LGA-wide	All	GCC	NSW Maritime, DECCW, DII - Fisheries	R11, W29, W38		$ 30,000	$ 6,000	$ 93,564		2	3	3	0	0	0	0	0	0	2	10	1		11.5
P44	Foreshore Development	Planning	Develop a guiding policy regarding the water boundary determination for foreshore properties consistent with Clause 55N of the *Coastal Protection Act 1979* .	Estuary Foreshores	All	LPMA	GCC		P43	$ 20,000	$ -	$ 20,000		1	4	0	4	0	0	-1	-2	0	0	6	2		9
P47	Foreshore Development	Planning	Enforce jetty sharing arrangements via the leasing mechanism such that each jetty services 2-3 properties. This will involve review of applications for new leases as well as license/lease renewals.	Waterway-wide	All	LPMA		P33, P46		$ 25,000	$ -	$ 25,000		2	1	1	0	1	2	-1	0	0	0	6	2		9
P46	Foreshore Development	Planning	Review existing *DCP 119 - Wharves and Jetties* with a view to ensuring the policy is in accordance with the goals and objectives of the Estuary Management Study and Plan. In addition, sea level rise projections should also be considered where facilities are to be upgraded.	LGA-wide	All	GCC	LPMA	P45	P43	$ 12,500	$ -	$ 12,500		0	2	2	0	0	1	0	0	0	0	5	2		8
P51	Foreshore Development	Planning	Implement development setbacks to provide for increased public access to the Estuary foreshores where new development occurs or existing sites are re-developed.	Estuary Foreshores	All	GCC		P50, P44, W82	P43	Undertaken as part of general Development Compliance assessments.	$ -	N/A		0	2	0	0	0	0	3	0	0	0	5	2		8
P52	Foreshore Development	Planning	Assess the need to strengthen existing controls or develop new controls relating to foreshore development to provide for public right of way along the foreshore.	Estuary Foreshores	All	GCC		P44, P45, P52, W82	P43	$ 30,000	$ -	$ 30,000		0	0	0	1	0	0	3	-2	0	0	2	1		3.5
W56	Foreshore Flooding/Inundation	Works	Seek to remediate scouring currently occurring behind the existing seawall in Illoura Reserve. This may necessitate replacement of the existing seawall with a new, environmentally friendly seawall structure.	Davistown	All	GCC	DII - Fisheries	W47, W48	W34	Under Floodplain Management Program.	$ -	N/A		0	1	3	2	0	0	0	0	0	0	6	1		7.5
W59	Foreshore Flooding/Inundation	Works	Restore flows to Woy Woy Creek by de-commissioning the dam at the former abattoir site.	Woy Woy Creek	3	GCC	DWE	W40		Refer to linked option.	$ -	N/A		1	1	1	1	0	0	0	0	0	0	4	2		7
W63	Foreshore Flooding/Inundation	Works	Investigate and implement options to address the issue of drainage from private properties along Mundoora Avenue onto the public reserve.	Yattalunga	2	GCC				$ 80,000	$ 5,000	$ 132,970		1	1	1	0	0	0	1	-1	0	0	3	2		6
W60	Foreshore Flooding/Inundation	Works	Where possible, provide for managed retreat of infrastructure from foreshore areas likely to be affected by sea level rise.	Estuary Foreshores	All	GCC	DECCW		P43	$ 250,000	$ 300,000	$ 3,428,204		0	3	3	5	-3	0	-3	-3	0	0	2	2		5
W62	Foreshore Flooding/Inundation	Works	Investigate and implement options to improve flow from the stormwater outlets located in the Lions Memorial Park on Brick Wharf Road, to include a program of ongoing weed removal. A fish friendly tide gate/flap should also be considered to prevent estuarine ingress when the outlet is inundated.	Woy Woy	4	GCC	Volunteers	W43, W80		$ 100,000	$ 10,000	$ 205,940		1	0	-1	1	0	0	0	0	0	0	1	2		4
W58	Foreshore Flooding/Inundation	Works	Control mangrove growth where they are affecting key drainage channels.	Catchment Tributaries	All	GCC	Volunteers	W57, W61		$ 55,000	$ 22,000	$ 288,068	NSW Floodplain Management Program (pending outcome of *Brisbane Water Floodplain Risk Management Study and Plan*)	-1	1	-2	3	0	0	0	0	0	0	1	1		2.5
W64	Foreshore Flooding/Inundation	Works	Undertake to improve drainage in the creek by dredging accreted sediments near Avoca and Sun Valley Drives.	Green Point	2	GCC		W01		$ 55,000	$ -	$ 55,000		0	1	-1	1	0	0	0	0	0	0	1	1		2.5

Option ID	Management Goal Addressed	Management Category	Strategy Outline	Location	Zone	Primary Responsibility	Secondary Responsibility	Cross Reference with Option:	Dependency on Option:	Preliminary Indicative Estimate of Capital Cost	Preliminary Indicative Estimate of Annual Maintenance/ Recurrent Cost/ Revenue (-ve values)	Net Present Value	Potential Funding Stream	Water & Sediment Quality	Sedimentary Processes	Ecological Processes	Foreshore Flooding / Inundation	Cultural Heritage	Visual Amenity	Recreational Usage	Development	Governance	Information, Communications and Education	Raw Benefit Index	Council / DECCW Response	Community Response	Adjusted Benefit Index
W57	Foreshore Flooding/Inundation	Works	Remove the mangroves from Turo Creek to permit the passage of flood flows from the catchment.	Pretty Beach	6	GCC	Volunteers	W61	W58	$ 45,000	$ 5,000	$ 97,970	NSW Floodplain Management Program (pending outcome of *Brisbane Water Floodplain Risk Management Study and Plan*)	-1	1	-1	1	0	0	0	0	0	0	0	1		1.5
W61	Foreshore Flooding/Inundation	Works	Undertake to remove mangroves currently impeding flow out of the stormwater outlets located near the train station on Railway Street.	Woy Woy	3	GCC		W57	W58	$ 80,000	$ -	$ 80,000	NSW Floodplain Management Program (pending outcome of *Brisbane Water Floodplain Risk Management Study and Plan*)	-1	1	-1	1	0	0	0	0	0	0	0	1		1.5
P58	Governance	Planning	Ensure the ongoing involvement of the Coasts and Estuaries Management Committee in the implementation of the Plan. Representation from the community, Council and from all the agencies responsible for implementation of the Plan should be maintained at all times.	Catchment-wide/Waterway-wide	All	GCC	DECCW	P36-P38, W113		Coasts and Estuaries Portfolio	$ -	N/A		2	2	2	2	1	1	1	0	4	2	17	1		18.5
P59	Governance	Planning	Develop a Vision Statement for the Brisbane Water Estuary consistent with the goals and objectives of the Plan.	Catchment-wide/Waterway-wide	All	GCC		P36-P38, W114		$ 5,000	$ -	$ 5,000		0	0	3	0	1	1	1	1	5	5	17	1		18.5
R37	Governance	Research/Monitoring	Design an Estuary Monitoring Plan to include elements of the physical, social and biological environment to evaluate the success in meeting the objectives and goals outlined in the Estuary Management Plan. The monitoring program should be designed with consideration of the unique characteristics of the Estuary and support the recommendations of the Brisbane Water Estuary Process Study. Consideration should be given to including monitoring for climate change impacts.	Catchment-wide/Waterway-wide	All	GCC		R37, R40		$ 25,000	$ 55,000	$ 607,671		4	4	4	3	2	1	1	0	5	5	29	2		32
R36	Governance	Research/Monitoring	Establish an annual reporting mechanism to communicate progress towards achieving the goals and objectives of the Management Plan, with specific reference to any actions or monitoring undertaken during that year, as well as the effectiveness of implementation of the Plan based on comparison with specific performance targets/indicators. The annual report should be distributed amongst Council, the CEMC and the community to ensure that all parties are informed of the Plan.	Catchment-wide/Waterway-wide	All	GCC		R40	R38	$ -	$ 15,000	$ 158,910		3	3	3	3	2	1	1	0	5	5	26	1		27.5
R38	Governance	Research/Monitoring	Research possible sources of funding and secure ongoing funding for implementation of the Plan. It is anticipated that responsibility and funding for these studies/plans may be shared across State, Federal and local government agencies.	Catchment-wide/Waterway-wide	All	GCC		R38		Currently underway	$ -	N/A		2	3	3	3	3	1	1	0	5	0	21	1		22.5
W113	Governance	Works	Establish a new position of River-Keeper for Brisbane Water following the NSW Maritime model.	Waterway-wide	All	NSW Maritime	GCC, CMA, DECCW	P58, P59, R36-R38		$ -	$ 100,000	$ 1,059,401		1	1	1	1	1	1	1	0	2	2	11	0		11
C04	Habitat and Species Conservation	Compliance	Ensure ongoing enforcement of fishing regulations.	Waterway-wide	All	DII - Fisheries		E01		$ -	$ 30,000	$ 317,820		1	0	3	0	0	0	3	0	0	3	10	1		11.5
C05	Habitat and Species Conservation	Compliance	Ensure the ongoing enforcement of Council's Tree Vandalisation Policy. Reference should also be made to *D6.44 Landscape and Vegetation Management Policy* .	LGA-wide	All	GCC		C06		$ -	$ 25,000	$ 264,850		1	1	2	1	1	2	0	0	0	2	10	1		11.5
C06	Habitat and Species Conservation	Compliance	Investigate measures to address vandalism of regionally significant vegetation located in the reserve near Carrak Road. Measures may include the imposition of fines, education or fencing.	Kincumber	5	GCC		C05		$ 30,000	$ 5,000	$ 82,970		0	0	2	0	0	1	0	0	0	0	3	2		6
E01	Habitat and Species Conservation	Education	Distribute available NSW Maritime seagrass maps to boaters and anglers to reduce impacts on seagrass from dinghies, motors and anchors. These maps should enclose information about the community's obligations with respect to preservation of seagrasses, such as DPI's Recreational Fishing Handbooks, which contain information on marine conservation.	Registered Boat Owners	All	DII - Fisheries	CMA, Fishcare Volunteers	C08, E11, E13, P18, P21, P25, P34, R22, W658		$ 15,000	$ 2,500	$ 41,485		0	0	3	0	0	0	-1	0	0	3	5	2		8
P15	Habitat and Species Conservation	Planning	Re-assess existing zoning and tenure of foreshore land with a view to providing for a range of human usages (recreational and commercial), as well as environmental protection, with due consideration of the potential impacts of climate change.	Estuary Foreshores	All	LPMA	GCC	P16, P44-P45, P48-P52, W60, W84	W34	$ 45,000	$ -	$ 45,000		0	2	3	2	2	2	3	2	0	0	16	1		17.5
P25	Habitat and Species Conservation	Planning	For those areas of seagrass at Ettalong shown to be important for fish recruitment, develop a strategy to protect and conserve them, including an education program for beach users, and undertake regular monitoring to assess the condition of the seagrass.	Ettalong	6	GCC	CMA, DII - Fisheries, CCCEN	E01, P09, P18, P20, P21, R20, R23, W65		$ 45,000	$ 30,000	$ 362,820		1	0	5	0	0	0	2	2	0	2	12	2		15
P28	Habitat and Species Conservation	Planning	Provide adequate resources within Council to provide for ongoing management of Bushcare volunteers.	LGA-wide	All	GCC		W71, W73, W76, W78, W80		$ -	$ 80,000	$ 847,521		1	1	5	0	0	1	1	0	0	3	12	2		15
P17	Habitat and Species Conservation	Planning	Develop an Estuary-wide strategy for the management of aquaculture.	Waterway-wide	All	DII - Fisheries	GCC	W74, W100		$ 40,000	$ 2,200	$ 63,307		2	0	3	0	0	1	-1	3	0	3	11	1		12.5
P16	Habitat and Species Conservation	Planning	Investigate opportunities to purchase saltmarsh areas for incorporation into Council's reserve system in accordance with policy *R0.15 - Acquisition of Wetlands* .	Estuary Foreshores	All	GCC	LPMA	R19		$ -	$ 500,000	$ 5,297,007		1	1	4	2	0	0	1	0	0	0	9	2		12
P20	Habitat and Species Conservation	Planning	Develop a conservation and education strategy for seagrass beds that support the highest diversity and abundance of fish, for beds at Koolewong, Woy Woy Bay, Woy Woy Inlet, Saratoga, and Davistown.	Koolewong, Woy Woy Bay, Woy Woy Inlet, Saratoga, and Davistown	All	GCC	DII - Fisheries, University of Newcastle, Fishcare Volunteers	E01, P18, P21, P22, P25, R20, W65		$ 35,000	$ 10,000	$ 140,940		1	0	5	0	0	0	1	0	0	3	10	1		11.5
P21	Habitat and Species Conservation	Planning	Develop a conservation and education strategy for seagrass beds known to be important for sponges and ascidians: Point Clare, Saratoga, Kincumber, Yattalunga, Pretty Beach, Wagstaff Point.	Point Clare, Saratoga, Kincumber, Yattalunga, Pretty Beach, Wagstaff Point	All	GCC	DII - Fisheries, DECCW, University of Newcastle	E01, P18, P20, P22, P25, R20, W65		$ 35,000	$ 10,000	$ 140,940		1	0	5	0	0	0	0	0	0	3	9	1		10.5
P27	Habitat and Species Conservation	Planning	Develop a Plan of Management to provide protection for the Green and Golden Bell Frog and the Bush Stone Curlew populations occurring in Davistown.	Davistown	5	GCC	University of Newcastle	E05, P23, P24		$ 55,000	$ -	$ 55,000	Australian Bird Environment Foundation Grant	1	0	5	0	0	0	0	0	0	1	7	2		10
P23	Habitat and Species Conservation	Planning	Develop a conservation strategy for the birds of Brisbane Water Estuary that addresses the main issues of disturbance by pedestrians, dog-walkers and watercraft, predation by feral and domestic animals and habitat loss/degradation.	Waterway-wide/Catchment-wide	All	GCC	CMA, DECCW, local bird watching clubs	E05, P24, P27		$ 30,000	$ 10,000	$ 135,940	Australian Bird Environment Foundation Grant	0	0	5	0	0	0	1	0	0	0	6	2		9
P24	Habitat and Species Conservation	Planning	Develop conservation and education strategies for the Bush Stone-Curlew of Brisbane Water.	Kincumber Broadwater, Woy Woy	3, 5	GCC	CMA, DECCW, local bird watching clubs	P23, P27, C10		$ 30,000	$ 10,000	$ 135,940	Australian Bird Environment Foundation Grant	0	0	3	0	0	0	1	0	0	2	6	2		9
P26	Habitat and Species Conservation	Planning	Re-zone ecologically sensitive portions of the Estuary waterbody *W2 - Environmental Protection* under Council's forthcoming LEP.	Waterway-wide	All	GCC	DoP	E05, P24		$ 15,000	$ -	$ 15,000		3	2	4	0	0	1	-3	-3	0	2	6	2		9
P19	Habitat and Species Conservation	Planning	Develop a strategy for the conservation of areas (e.g. estuarine protected areas) important for the biodiversity of invertebrates. Particular attention should be paid to priority sites that represent the greatest proportion of species, including Ettalong, Narara Creek, Koolewong, and Woy Woy Bay-Pelican Island.	Ettalong, Narara Creek, Koolewong, and Woy Woy Bay-Pelican Island	All	GCC	DII - Fisheries, DECCW, University of Newcastle	P21, P22		$ 50,000	$ 22,000	$ 283,068		1	0	5	0	0	0	-2	0	0	3	7	1		8.5

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P29	Habitat and Species Conservation	Planning	Develop a "Green Offsets" Policy aimed at: - Ensuring significant vegetation in the LGA is protected, - Facilitating some development that may have some negative environmental impacts, - Ameliorating the negative impacts of development at a local and regional scale, and - Providing for environmental enhancement and restoration.	LGA-wide	All	GCC		C05, C06		$ 150,000	$ -	$ 150,000		1	1	2	0	0	1	0	2	0	0	7	1		8.5
P22	Habitat and Species Conservation	Planning	Provide protection for those areas identified in the Estuary Processes Study as being important for biological connectivity in the Estuary.	Waterway-wide/Catchment-wide	All	GCC	DII - Fisheries, DECCW	P26, P38		$ 30,000	$ -	$ 30,000		0	0	5	0	0	0	0	0	0	0	5	2		8
P30	Habitat and Species Conservation	Planning	Develop a DCP for Wetlands aimed at maintaining and restoring natural biological and physical processes of wetland function by minimising changes to wetland hydrology from land uses in the catchment.	LGA-wide	All	GCC		C13, P04		$ 40,000	$ -	$ 40,000		2	1	2	0	0	1	0	-1	0	0	5	1		6.5
P18	Habitat and Species Conservation	Planning	Develop a strategy to protect seagrass beds known to be important for syngnathid fishes (seahorses, pipefish).	Waterway-wide	All	GCC	DII - Fisheries	E01, P20-P22, P25, R20, W65		$ 35,000	$ 10,000	$ 140,940		1	0	4	0	0	0	0	0	0	0	5	0		5
R24	Habitat and Species Conservation	Research/Monitoring	Investigate the use of constructed wetlands, sediment, and detention basins and other WSUD options to minimise the effect of freshwater and sediment inflows, with particular reference to areas of high biodiversity value around entrances to creeks. Consideration should be given to both current and future meteorological conditions.	Catchment-wide	All	GCC	CMA	W01		Refer to linked option.	$ -	N/A		3	4	3	5	0	0	2	0	0	0	17	1		18.5
R26	Habitat and Species Conservation	Research/Monitoring	Develop a research partnership with universities to continue the scientific focus on Brisbane Water Estuary and support this with annual research grants.	LGA-wide	All	GCC	Universities	E06, P19-P21, P27, P38		$ 30,000	$ 40,000	$ 453,761	Australian Research Council Grants	2	2	3	1	1	0	0	2	1	5	17	1		18.5
R22	Habitat and Species Conservation	Research/Monitoring	Monitor the extent and condition of riparian, foreshore and aquatic vegetation around the Brisbane Water Estuary. Trends in vegetation condition and extent should be reported annually.	Waterway-wide/Catchment-wide	All	GCC	CMA, DII - Fisheries	R20, R36, R37		$ 12,500	$ 60,000	$ 648,141		0	1	4	1	0	1	0	0	0	3	10	2		13
R21	Habitat and Species Conservation	Research/Monitoring	Revise SEPP14 boundaries based on latest wetland vegetation mapping.	LGA-wide	All	DoP	DII - Fisheries			$ 35,000	$ -	$ 35,000		0	0	5	0	0	0	0	0	0	3	8	2		11
R18	Habitat and Species Conservation	Research/Monitoring	Conduct a survey of recreational fishing catches and analyse recreational fishing trends to characterise both the impact on the fish populations of Brisbane Water Estuary and the value of recreational fishing as a local industry.	Waterway-wide	All	DII - Fisheries	University of Newcastle, Fishcare Volunteers	E13, R18, R33		$ 55,000	$ -	$ 55,000	Recreational Fishing Trust	0	0	2	0	0	0	3	4	0	0	9	1		10.5
R19	Habitat and Species Conservation	Research/Monitoring	Investigate options for the landward migration of intertidal habitats such as saltmarsh under climate change scenarios.	Estuary Foreshores	All	GCC	CMA, DECCW	E8, P42, W60	P43	$ 60,000	$ -	$ 60,000		0	2	3	3	0	0	-2	0	0	0	6	2		9
R20	Habitat and Species Conservation	Research/Monitoring	Monitor indicator organisms within all ecosystems (saltmarsh, seagrass, mangroves, intertidal mud, subtidal mud, intertidal rock) through time to assess effectiveness of management measures to protect biodiversity and maintain the ecological health of the Estuary.	Waterway-wide/Catchment-wide	All	GCC	CMA, DECCW, DII - Fisheries	R36, R37		$ 20,000	$ 85,000	$ 920,491		0	0	4	0	0	0	0	0	0	3	7	1		8.5
R25	Habitat and Species Conservation	Research/Monitoring	Monitor the status and extent of *Caulerpa taxifolia* in the Estuary and undertake a program of eradication.	Waterway-wide	All	DII - Fisheries	CMA	E13		$ 50,000	$ 22,000	$ 283,068	Recreational Fishing Trust	0	0	2	0	0	0	0	0	0	2	4	2		7
R23	Habitat and Species Conservation	Research/Monitoring	Audit and assess the route used by the Palm Beach - Ettalong ferry. Where possible, the navigation route used by the ferry should avoid seagrass beds in this location.	Ettalong	6	NSW Maritime	DII - Fisheries	C08, R34		$ 15,000	$ -	$ 15,000		0	2	2	0	0	0	-1	0	0	0	3	1		4.5
W71	Habitat and Species Conservation	Works	Where appropriate, rehabilitate saltmarsh habitats, with saltmarshes at Saratoga, Empire Bay, Davistown and Riley's Island addressed as a priority.	Saratoga, Empire Bay, Davistown and Riley's Island	All	GCC	DECCW, CMA, Bushcare Volunteers	W69, W70		$ 60,000	$ 15,000	$ 218,910	Caring for Our Country Grant	2	3	5	1	0	1	0	0	0	0	12	1		13.5
W69	Habitat and Species Conservation	Works	Review existing sea walls in Council's foreshore parks to investigate possibility of returning natural foreshore and/or use of alternative materials that will: a) Increase the number of ecological niches, and b) Increase dissipation of wave energy. Reference should be made to DECCW's *Environmentally Friendly Seawalls guidelines*.	Estuary Foreshores	All	GCC	LPMA, DECCW, CMA	R15, W36, W43, W47, W54	W56, W41, R48	$ 50,000	$ 50,000	$ 579,701		1	3	5	-1	-1	1	0	0	0	0	8	2		11
W76	Habitat and Species Conservation	Works	Rehabilitate the saltmarshes in Yattalunga Bay, to include the strategic removal of mangroves, weeding and control of nutrient inputs. Methods to address the source of weeds and nutrient inputs should also be considered.	Yattalunga Bay	2	GCC	Volunteers	R20, W01, W73	W68	$ 55,000	$ 12,000	$ 182,128	Caring for Our Country Grant	2	1	4	1	0	1	0	0	0	0	9	1		10.5
W70	Habitat and Species Conservation	Works	Fence existing saltmarshes to prevent access by vehicles, bikes and domestic animals.	Estuary Foreshores	All	GCC	CMA, Bushcare Volunteers	W71		$ 250,000	$ 15,000	$ 408,910	Caring for Our Country Grant	1	3	4	1	0	-1	-1	0	0	1	8	1		9.5
W65	Habitat and Species Conservation	Works	Replace existing swing moorings within the Estuary with more appropriate, seagrass friendly moorings.	Waterway-wide	All	NSW Maritime		R31, R32	P36	$ -	$ 7,500	$ 79,455		0	3	2	0	0	0	0	0	0	0	5	2		8
W73	Habitat and Species Conservation	Works	Conduct weed control activities in Council's foreshore reserves.	Estuary Foreshores	All	GCC	Bushcare Volunteers	W72		$ -	$ 7,500	$ 79,455		0	0	5	0	0	0	0	0	0	0	5	2		8
W77	Habitat and Species Conservation	Works	Provide alternative dinghy storage arrangements and fence the Endangered Ecological Community (EEC) at Mason Pde, Gosford. Ensure ongoing enforcement of prohibition of dinghy storage impacting on the EEC adjacent to the Scout Hall in this location.	Mason Pde, Gosford	2	GCC		C07, P35, P36, W86		$ 80,000	$ 5,000	$ 132,970		1	1	2	0	0	0	1	0	0	0	5	2		8
W79	Habitat and Species Conservation	Works	Replace existing tide gates/flaps fixed to stormwater outlets with fish friendly tide gates/flaps.	Estuary Foreshores	All	GCC	DII - Fisheries	W66, W67		$ 45,000	$ 25,000	$ 309,850	Recreational Fishing Trust	0	1	4	0	0	0	0	0	0	0	5	2		8
W68	Habitat and Species Conservation	Works	Investigate the issue of mangrove habitat expansion at the expense of other estuarine habitats (esp. saltmarsh). Key locations where this process is occurring should be identified and appropriate mangrove control management actions developed in conjunction with DII Fisheries.	Waterway-wide	All	GCC	DII - Fisheries, Volunteers	R20, W57, W58, W61, W76		$ 100,000	$ 15,000	$ 258,910		0	1	4	1	0	0	0	0	0	0	6	1		7.5
W72	Habitat and Species Conservation	Works	Conduct feral animal control in Council's foreshore reserves.	Estuary Foreshores	All	GCC		W73		$ -	$ 20,000	$ 211,880		1	0	5	0	0	0	0	0	0	0	6	1		7.5
W75	Habitat and Species Conservation	Works	Where possible, re-introduce native cockles and other shellfish to suitable depleted habitats (such as seagrass beds in Hardy's Bay, Pretty Beach and Riley's Bay).	Hardy's Bay, Pretty Beach and Riley's Bay	6	DII - Fisheries				$ 15,000	$ 15,000	$ 173,910		1	0	2	0	0	0	0	0	0	0	3	2		6
W66	Habitat and Species Conservation	Works	Provide fish friendly structures where new instream structures are being constructed.	Catchment Tributaries	All	GCC, RTA	DII - Fisheries	W67		$ -	$ 60,000	$ 635,641	Recreational Fishing Trust	0	0	1	0	0	0	0	0	0	0	1	2		4
W67	Habitat and Species Conservation	Works	Identify existing instream infrastructure (e.g. weirs and culverts) for replacement or retrofitting to fish friendly status.	Catchment Tributaries	All	GCC, RTA	DII - Fisheries	W66		$ 10,000	$ 60,000	$ 645,641	Recreational Fishing Trust	0	0	1	0	0	0	0	0	0	0	1	2		4
W74	Habitat and Species Conservation	Works	Where feasible, clean up both active and inactive oyster leases to remove rubble, oyster shells and other rubbish.	Waterway-wide	All	DII - Fisheries	Volunteers	P17		$ -	$ 15,000	$ 158,910		1	2	0	0	-1	1	1	0	0	0	4	0		4
W78	Habitat and Species Conservation	Works	Undertake program of weed removal in Horsfield Bay and Correa Bay foreshore reserves.	Horsfield Bay, Correa Bay	3	GCC	Volunteers	W73		Refer to linked option.	$ -	N/A		0	-1	1	0	0	1	0	0	0	0	1	2		4
W80	Habitat and Species Conservation	Works	Undertake program of weed removal in Lions Memorial Park on Brick Wharf Road, around the boat ramp in particular.	Woy Woy	4	GCC	Volunteers	W73		Refer to linked option.	$ -	N/A		0	-1	1	0	0	1	0	0	0	0	1	2		4
C08	Recreational Usage	Compliance	Enforce boating regulations (particularly speed restrictions and zoning of activities) within Brisbane Water.	Waterway-wide	All	NSW Maritime		E01, E11, E12, W05, C12, C16	C09	$ -	$ 50,000	$ 529,701		2	3	1	0	0	0	3	0	0	3	12	0		12
C07	Recreational Usage	Compliance	Ensure enforcement of the requirement to use formal dinghy storage racks provided by Council. This should include the confiscation of improperly stored dinghies or fining of the owners.	Estuary Foreshores	All	GCC		W77	P35, W86	$ -	$ 25,000	$ 264,850		0	2	1	0	2	2	3	0	0	0	10	0		10
C10	Recreational Usage	Compliance	Enforce on-leash dog walking in restricted areas.	Catchment-wide	All	GCC				$ -	$ 30,000	$ 317,820		-2	0	2	0	0	0	2	0	0	2	4	2		7
C09	Recreational Usage	Compliance	Install solar powered speed cameras in problematic areas for enforcement of speed restrictions for boats.	Waterway-wide	All	NSW Maritime		C16	C16	$ 60,000	$ -	$ 60,000		0	1	0	0	0	0	1	0	0	1	3	1		4.5

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C12	Recreational Usage	Compliance	Investigate options for either banning or further limiting the use of jet skis in Brisbane Water Estuary.	Waterway-wide	All	NSW Maritime	GCC	C08		$ 12,500	$ -	$ 12,500		1	1	1	0	0	0	0	-1	0	0	2	1		3.5
C11	Recreational Usage	Compliance	Prohibit all vehicular traffic along the sand on beaches (excl. vehicles used by Surf Life Savers).	Estuary Foreshores	All	GCC, SLSA				$ 5,000	$ -	$ 5,000		1	2	1	0	0	0	-1	0	0	0	3	-1		1.5
P41	Recreational Usage	Planning	Prepare a *Brisbane Water Estuary Users Plan* which addresses such issues as equity of access, boat storage, conflicts of usage, mooring types and caps, number and type of public access points (wharves and jetties), coverage and consistency of foreshore Plans of Management with priority areas identified for new Plans of Management, estimation of an estuary carrying capacity with respect to development intensity, fishing/fisheries and boating.	Estuary Foreshores/Waterway-wide	All	GCC		C12, P37, P55, R33, W81	R31, R32	$ 60,000	$ -	$ 60,000		2	2	5	0	0	2	5	5	0	5	26	2		29
P36	Recreational Usage	Planning	Review of policies relating to boating use of the Estuary with a view to providing a balance between recreational and ecological uses. The review should include an assessment of policies relating to: - Speed limits, - No wash areas, - Dinghy storage areas, - Moorings, and - Jetties.	Estuary Foreshores/Waterway-wide	All	GCC	NSW Maritime, LPMA, University of Newcastle	P08, P37, P41, P48, R31, R32		$ 35,000	$ -	$ 35,000		2	2	2	0	0	0	3	0	0	0	9	2		12
P38	Recreational Usage	Planning	Undertake a public consultation process for input into planning for protection of areas of the Estuary important for biodiversity, habitats and ecological processes.	LGA-wide	All	GCC	DII - Fisheries, DECCW, University of Newcastle	P17-P25, R25		$ 35,000	$ -	$ 35,000		2	0	5	0	0	0	0	0	0	3	10	1		11.5
P42	Recreational Usage	Planning	Update the existing *Ettalong Beach Plan of Management* in line with the findings of the *Brisbane Water Estuary Processes Study* and in line with the objectives of the *Estuary Management Plan* .	Ettalong	6	GCC		P12, R11, W28, W29, W97		$ 60,000	$ -	$ 60,000		0	1	1	1	1	1	1	1	1	0	8	1		9.5
P35	Recreational Usage	Planning	Develop a guideline for the installation of dinghy storage racks covering: - Suitable types of storage racks, and - Suitable locations for installation compatible with existing uses and ecological constraints.	Estuary Foreshores	All	GCC		C07, P36, W77	R31, W86	Currently underway	$ -	N/A		0	1	1	0	0	1	2	0	0	0	5	2		8
P33	Recreational Usage	Planning	Provide linkages between different portions of publicly accessible foreshores by linking with other foot or cycle paths and public transport linkages.	Catchment-wide	All	GCC		W41, W82, W84, W94, W104, W110		$ 20,000	$ -	$ 20,000		0	0	0	0	0	0	4	0	0	0	4	2		7
P39	Recreational Usage	Planning	Assess options for relocation of the Pretty Beach pool such that it will be suitable for swimming under all tidal conditions and is not subject to sediment build-up.	Pretty Beach	6	GCC		W30-32		$ 55,000	$ -	$ 55,000		1	1	0	1	0	0	1	0	0	0	4	1		5.5
P34	Recreational Usage	Planning	Investigate options for further zonation of the waterway for different water-based recreational activities, with due consideration of ecologically sensitive areas. This option would involve re-assessment of the existing boating map for Brisbane Water prepared by NSW Maritime.	Waterway-wide	All	NSW Maritime		P26 , P36, P37	P41	$ 55,000	$ -	$ 55,000		3	0	1	0	0	0	-2	-1	0	0	1	2		4
P37	Recreational Usage	Planning	Provide either a speed restriction or ban on water skiing in Waterfall Bay in order to minimise conflicts between houseboats and water skiers.	Waterfall Bay	3	NSW Maritime		C08, C09, P41		$ 10,000	$ 5,500	$ 68,267		0	0	1	0	0	0	1	0	0	0	2	1		3.5
P40	Recreational Usage	Planning	Identify 'green' alternatives for the disposal of seaweed removed from the Estuary foreshores (e.g. use in gardening activities).	Estuary Foreshores	All	GCC	Volunteers			$ 7,500	$ -	$ 7,500		0	0	3	0	0	0	0	0	0	0	3	0		3
R31	Recreational Usage	Research/Monitoring	Conduct an audit of existing land-based and water-based infrastructure for boating (e.g. picnic tables, playgrounds, BBQs, jetties, boat ramps, dinghy storage areas, moorings, trailer parking areas, etc.) focusing on: - Patterns in patronage/usage, - Condition and maintenance requirements, - Characterisation of neighbouring land uses, - Proximity to key habitat, heritage items and other environmentally sensitive areas, - Proximity to key locations (e.g. pump out stations, marinas, popular fishing spots, etc.), and - Safety. Based on the outcome of the audit, assess the need to upgrade, maintain or de-commission existing infrastructure.	Estuary Foreshores/Waterway-wide	All	GCC	LPMA, NSW Maritime	P34-P37, P41, P47, P55, R32, W69, W77, W81, W86, W93, W94-W96	P43	$ 120,000	$ -	$ 120,000		1	1		1	1	1	5	2	0	0	12	2		15
R33	Recreational Usage	Research/Monitoring	Survey recreational fishermen to characterise demand, target species, gear type, etc.	Waterway-wide	All	DII - Fisheries	GCC, Fishcare Volunteers	E13, R18		$ 55,000	$ -	$ 55,000	Recreational Fishing Trust	0	0	3	0	0	0	4	3	0	0	10	1		11.5
R32	Recreational Usage	Research/Monitoring	Undertake an audit of the number, configuration and demand for existing moorings in Brisbane Water Estuary. Assess the need to increase the number of moorings and identify suitable locations with due consideration of the carrying capacity of the Estuary. Moorings should be concentrated in close proximity to associated shore-based facilities (e.g. dinghy storage racks).	Waterway-wide	All	NSW Maritime		P36, W65	R31	$ 20,000	$ -	$ 20,000		0	1	-2	0	0	3	3	3	0	0	8	0		8
R34	Recreational Usage	Research/Monitoring	Audit and assess the route used by the Palm Beach - Ettalong ferry. Where possible, the navigation route used by the ferry should avoid popular bathing spots in this location.	Ettalong	6	NSW Maritime	GCC	C08, R23		$ 20,000	$ -	$ 20,000		0	1	-2	0	0	0	2	0	0	0	1	2		4
R35	Recreational Usage	Research/Monitoring	Investigate options for improving public access over the rail line to the foreshore adjacent to Railway Street.	Woy Woy	3	GCC	RailCorp			$ 50,000	$ -	$ 50,000		0	0	-1	0	0	-1	1	0	0	0	-1	2		2
W84	Recreational Usage	Works	Provide boardwalks at sensitive foreshore locations to permit public access.	Estuary Foreshores	All	GCC		P50-P52, W94	W81	$ 20,000	$ 100,000	$ 1,079,401		2	1	2	1	1	2	3	0	0	0	12	1		13.5
W83	Recreational Usage	Works	Identify priority, privately owned/managed parcels of foreshore land for acquisition and/or incorporation into publicly accessible foreshore land.	Estuary Foreshores	All	LPMA	GCC	P50-P52, W94	W81	$ -	$ 550,000	$ 5,826,708		0	1	2	1	1	2	3	0	0	0	10	1		11.5
W86	Recreational Usage	Works	Provide paid, secure dinghy storage facilities at strategic locations around Brisbane Water Estuary. Suggested priority areas include Koolewong, around Gosford and Green Point.	Estuary Foreshores	All	GCC	NSW Maritime	C07	P35, P36	$ 250,000	$ 10,000	$ 355,940	NSW Maritime - Maritime Infrastructure Program	0	3	1	0	1	2	3	0	0	0	10	1		11.5
W91	Recreational Usage	Works	Provide bins and bags for the disposal of animal faeces by dog walkers.	Catchment-wide	All	GCC		C10, W89		$ 15,000	$ 10,000	$ 120,940		3	0	1	0	0	1	3	0	0	0	8	2		11
W93	Recreational Usage	Works	Provide additional rubbish and recycling bins along the foreshore, focusing on access points and targeting heavily utilised foreshore reserves as a priority.	Estuary Foreshores	All	GCC			R31	$ 25,000	$ 15,000	$ 183,910		2	0	2	0	0	0	3	0	0	0	7	1		8.5
W104	Recreational Usage	Works	Improve public access along the foreshore reserve between Ironbark Point and Rocky Point. Assess the feasibility of installing a boardwalk, undertaking foreshore stabilisation works and/or creating a public path in front of houses between 36-40 Asca Drive.	Green Point	2	GCC		W82		$ 175,000	$ 10,000	$ 280,940		0	1	1	0	0	1	1	0	0	0	4	2		7
W82	Recreational Usage	Works	Seek to provide a publicly accessible pathway along the entire Estuary foreshore. This should be approached in a strategic fashion incorporating: a) Linkages with existing cycleways, pathways and public transport in the wider catchment, b) Safety by Design (e.g. through the provision of lighting), and c) Consideration of environmental constraints (e.g. gridded/light permeable boardwalks may be more suitable in ecologically sensitive areas).	Estuary Foreshores	All	GCC	LPMA	P50-P52, W83, W84, W94		$ -	$ 125,000	$ 1,324,252		-1	-1	0	0	1	2	5	0	0	0	6	0		6
W94	Recreational Usage	Works	Provide additional facilities for disabled and less mobile people, to include access ramps, seating, disabled parking etc.	Fagan's Bay, Woy Woy, Ettalong	All	GCC		W84, W85	R31	$ 600,000	$ 60,000	$ 1,235,641		0	0	0	0	0	0	3	0	0	0	3	2		6
W103	Recreational Usage	Works	Undertake a regular program of maintenance for the Yattalunga jetty and tidal pool to remove accreted sediments and clean out weed.	Yattalunga	2	GCC				$ -	$ 45,000	$ 476,731		1	1	0	0	0	1	1	0	0	0	4	1		5.5
W85	Recreational Usage	Works	Enforce the replacement of fixed public jetties with floating pontoons.	Waterway-wide	All	LPMA	GCC	P36, P46, W94		$ -	$ 220,000	$ 2,330,683		0	2	0	0	-2	2	2	0	0	0	4	1		5.5

Option ID	Management Goal Addressed	Management Category	Strategy Outline	Location	Zone	Primary Responsibility	Secondary Responsibility	Cross Reference with Option:	Dependency on Option:	Preliminary Indicative Estimate of Capital Cost	Preliminary Indicative Estimate of Annual Maintenance/ Recurrent Cost/ Revenue (-ve values)	Net Present Value	Potential Funding Stream	Water & Sediment Quality	Sedimentary Processes	Ecological Processes	Foreshore Flooding / Inundation	Cultural Heritage	Visual Amenity	Recreational Usage	Development	Governance	Information, Communications and Education	Raw Benefit Index	Council / DECCW Response	Community Response	Adjusted Benefit Index
W101	Recreational Usage	Works	Provide improved, safe access for recreational users accessing the foreshore and waterway near Victory Pde, Tascott, via re-configuration of the existing rock wall.	Tascott	2	GCC			W36, W37	$ 275,000	$ -	$ 275,000		0	-1	0	1	0	1	1	0	0	0	2	2		5
W112	Recreational Usage	Works	Identify measures to improve public access to Lance Webb Reserve and the beach in this location.	Ettalong	6	GCC		W82		$ 50,000	$ -	$ 50,000		0	0	1	0	0	0	1	0	0	0	2	2		5
W88	Recreational Usage	Works	Provide navigational markers for the following locations: - The sand bar in Correa Bay, and - The unmarked rock outcrop in Horsfield Bay.	Correa Bay, Horsfield Bay	3	NSW Maritime		W87	W88	$ 20,000	$ -	$ 20,000		0	0	1	0	0	0	1	0	0	0	2	2		5
W87	Recreational Usage	Works	Ensure that the navigation markers are moved in accordance with movement of the associated shoals.	Waterway-wide	All	NSW Maritime				$ -	$ 15,000	$ 158,910		0	0	0	-1	0	0	4	0	0	0	3	1		4.5
W92	Recreational Usage	Works	Instead of collecting rubbish from the Estuary foreshores via beach raking, collect by hand (to avoid ecological impacts).	Estuary Foreshores	All	GCC	Volunteers, Work for the Dole Program			$ -	$ 45,000	$ 476,731		0	1	2	0	0	0	0	0	0	0	3	1		4.5
W95	Recreational Usage	Works	Provide special parking for people transferring small children to prams at key recreational areas.	Fagan's Bay, Ettalong	All	GCC		W96	R31	$ 25,000	$ -	$ 25,000		0	0	0	0	0	0	3	0	0	0	3	1		4.5
W96	Recreational Usage	Works	Provide short-term 'loading zones' for recreational users (un)loading bikes or other equipment immediately adjacent to heavily utilised recreational sites.	Estuary Foreshores	All	GCC		W95	R31	$ 25,000	$ -	$ 25,000		0	0	0	0	0	0	3	0	0	0	3	1		4.5
W109	Recreational Usage	Works	Investigate and implement suitable options for improving drainage of the oval located near Willaroo Road.	Saratoga	4	GCC				$ 250,000	$ 10,000	$ 355,940		0	0	0	1	0	0	1	0	0	0	2	1		3.5
W111	Recreational Usage	Works	Remove and dispose of disused boat trailer and floating pontoon (Hawke Street).	Kincumber	5	GCC	LPMA			$ 20,000	$ -	$ 20,000		0	0	0	0	0	1	1	0	0	0	2	1		3.5
W97	Recreational Usage	Works	Provide additional access points to Ettalong Beach from Lance Webb Reserve.	Ettalong	6	GCC		P10, P12, W29, W55, W97	P42, R11	$ 55,000	$ -	$ 55,000		0	-1	1	0	0	0	2	0	0	0	2	1		3.5
W100	Recreational Usage	Works	Progress towards removal of oyster leases in Lintern Channel, west of Empire Bay, Riley's Island and Pelican Island.	Lintern Chanel, Empire Bay, Pelican Island	2, 4	DII - Fisheries		P17, W74		$ 60,000	$ -	$ 60,000		0	1	3	0	-1	2	0	-2	0	0	3	0		3
W102	Recreational Usage	Works	Provide recreational facilities including picnic benches and BBQs at Yattalunga Reserve.	Yattalunga Reserve	2	GCC	LPMA		P41, R31	$ 100,000	$ 17,500	$ 285,395		0	0	0	0	0	0	1	0	0	0	1	1		2.5
W110	Recreational Usage	Works	Provide a shared pedestrian pathway/cycleway in the reserve near Carrak Road to improve recreational access and link with other areas.	Kincumber	5	GCC		W82		$ 250,000	$ 5,000	$ 302,970		0	0	0	0	0	0	1	0	0	0	1	1		2.5
W98	Recreational Usage	Works	Provide additional public open space areas incorporating walking tracks in the Woy Woy area (to the waterfall and through the former abattoir site).	Woy Woy	3	GCC		W82, W99		$ 250,000	$ 20,000	$ 461,880		0	-1	0	0	0	1	1	0	0	0	1	1		2.5
W107	Recreational Usage	Works	Provide dedicated parking for users of the boat ramp near Punt Bridge.	Central Coast Hwy	2	GCC			P41	$ 80,000	$ 5,000	$ 132,970		0	0	-1	0	0	0	1	0	0	0	0	1		1.5
W105	Recreational Usage	Works	Extend Orana St boat ramp to permit access at low tide.	Green Point	2	GCC				$ 75,000	$ -	$ 75,000		0	-1	-1	0	0	0	1	0	0	0	-1	1		0.5
W89	Recreational Usage	Works	Provide additional off-leash dog walking areas.	Catchment-wide	All	GCC		C10, W91		$ 20,000	$ -	$ 20,000		-2	0	-1	0	0	0	3	0	0	0	0	0		0
W106	Recreational Usage	Works	Provide for regular removal of accumulated seagrass wrack from the beach opposite the Sailing Club at this popular recreational area.	Mason Pde and Dane Dr, Gosford	2	GCC				$ -	$ 12,500	$ 132,425		0	0	-1	0	0	1	1	0	0	0	1	-1		-0.5
W99	Recreational Usage	Works	Acquire the former abattoir site for incorporation into Council's system of public reserves.	Woy Woy	3	GCC	LPMA	W98		$ 3,500,000	$ -	$ 3,500,000		-4	0	1	0	0	0	1	0	0	0	-2	1		-0.5
W81	Recreational Usage	Works	Seek to provide additional facilities for the boating community to include slipways, shipwright services, travel lifts, re-fuelling areas and hard stand areas. The form and location of these additional facilities should be such that they are accessible by a range of vessels over the full tidal cycle.	Estuary Foreshores/Waterway-wide	All	LPMA	GCC	P35, P36, R32, W02, W85	R31, P41	$ -	$ 220,000	$ 2,330,683	NSW Maritime - Maritime Infrastructure Program	-3	-2	-2	0	0	-2	4	4	0	0	-1	0		-1
W108	Recreational Usage	Works	Undertake review of need requirements for the tidal baths located near Brisbane Water Drive. An upgrade from netting to stainless steel bars should be considered.	Woy Woy	4	GCC			P41	$ 250,000	$ 10,000	$ 355,940		0	-1	-1	0	0	0	1	0	0	0	-1	-1		-2.5
C15	Information, Communications and Education	Compliance	Enforce littering restrictions and undertake parallel education programs about littering.	LGA-wide	All	GCC		E02, E07, E11, R05, W91, W92		$ 20,000	$ 7,500	$ 99,455	Butt Littering Trust	2	0	1	1	0	2	0	0	0	4	10	1		11.5
C16	Information, Communications and Education	Compliance	Publish statistics on infringements of boating regulations.	LGA-wide	All	NSW Maritime		C09, C08	C08	$ -	$ 7,500	$ 79,455	Recreational Fishing Trust - Aquatic Habitat Rehabilitation Grant	0	0	1	0	0	0	0	0	2	2	5	0		5
E08	Information, Communications and Education	Education	Give consideration to methods of detecting and informing the community of changes to sea levels and other potential climate change impacts. These methods should not result in a sense of panic or alarm, instead they should empower the community to act in a well considered and informed manner and where possible, encourage the community to become engaged in Council's decision making processes. The information provided to the public should be supported by research presented by the IPCC and the State/Federal government.	LGA-wide	All	GCC	DECCW, CMA		P43	$ 25,000	$ -	$ 25,000	National Natural Disaster Mitigation Program	1	2	0	5	0	0	0	4	0	5	17	2		20
E09	Information, Communications and Education	Education	Provide foreshore property owners with information/guidelines about what constitutes good and bad practice with respect to foreshore management (e.g. limits of mowing, stabilisation works, etc.).	Foreshore Property Owners	All	GCC	LPMA	C02, C05, C14, E10, P11, P14, P44-P50		$ 30,000	$ 7,500	$ 109,455		2	2	3	3	0	1	0	0	0	3	14	2		17
E07	Information, Communications and Education	Education	Establish a 'Clean Up Brisbane Water Day' with the dual objectives of removing rubbish from the Estuary foreshores and waterways, and of educating the public about the Estuary.	Waterway-wide	All	GCC	NSW Maritime, DECCW	C15, E02, E11, R05, W91, W92, W93		$ 50,000	$ 50,000	$ 579,701		3	2	4	0	0	2	0	0	0	4	15	1		16.5
E06	Information, Communications and Education	Education	Develop public awareness and education programs about the biodiversity of Brisbane Water, the important underlying ecological processes, and their relationships with human uses of the Estuary. The programs should focus on locations of high conservation value as a priority.	LGA-wide	All	GCC	University of Newcastle, Central Coast Marine Discovery Centre	E03, E05, E07, P20, P21, P24, P25, P38, P53, R26, R36, R39	R20, R22	$ 100,000	$ 25,000	$ 364,850		1	0	4	0	0	0	0	0	0	5	10	2		13
E02	Information, Communications and Education	Education	Label stormwater drain inlets in problematic areas "This drains to ……".	Catchment-wide	All	GCC		C15, E07, R05		$ 20,000	$ 2,500	$ 46,485		3	2	3	0	0	-1	0	0	0	4	11	1		12.5
E04	Information, Communications and Education	Education	Develop a public awareness and education program focusing specifically on the biodiversity and ecological value of saltmarsh habitats.	LGA-wide	All	GCC	CMA, DECCW	E03, E05, E06, E09, P30, P49,	R20, R22	Implement via Option E06.	$ -	N/A		1	1	4	1	0	0	0	0	0	3	10	1		11.5
E11	Information, Communications and Education	Education	Conduct an education program for the boating community on: - Their responsibilities with respect to the disposal of ballast, sewage and rubbish, - The location of existing sewage pump-out and rubbish disposal facilities, and - How to safeguard against leaks and spills, and what to do if a leak or spill occurs.	LGA-wide	All	NSW Maritime		C08, C15, E12, P02, P46, P47, R23, R34, W05	P36, P41	$ 25,000	$ 10,000	$ 130,940		2	0	3	0	0	0	0	0	0	3	8	2		11
E13	Information, Communications and Education	Education	Provide an education program for recreational fisherman aimed at encouraging the reporting of information via fishing surveys, gamefish tagging and the occurrence of *Caulerpa taxifolia* .	LGA-wide	All	DII - Fisheries	Fishcare Volunteers	C04, P41, R18		$ 40,000	$ 12,500	$ 172,425		0	0	3	0	0	0	1	1	0	2	7	2		10
E03	Information, Communications and Education	Education	Develop interpretive signage promoting the biodiversity and value of different key habitat types in the Brisbane Water Estuary, to be placed along publicly accessible foreshores. Signage should be provided at locations of high conservation value as a priority.	Publicly accessible foreshore	All	GCC		E04, E05, E08, P18-P25, P28, P53, R20-R22, R25	E06, R39	$ 100,000	$ 20,000	$ 311,880		0	0	4	0	0	-2	2	0	0	4	8	1		9.5
E05	Information, Communications and Education	Education	Develop a public education and awareness program about the diversity of birds and the national significance of Brisbane Water Estuary for birds.	LGA-wide	All	GCC	CMA, DECCW, local bird watching clubs	C10, E03, E06, P23, P27, R26		Implement via Option E06.	$ -	N/A	Australian Bird Environment Foundation Grant	0	0	4	0	0	0	0	0	0	3	7	1		8.5

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E10	Information, Communications and Education	Education	Provide information about environmentally friendly seawall options to both the community and those individuals assessing development applications for these structures. Reference should be made to DECCW's *Environmentally Friendly Seawalls. A Guide to Improving the Environmental Value of Seawalls and Seawall-lined Foreshores in Estuaries.*	LGA-wide	All	DECCW	GCC, LPMA	P43-P45, P48		$ 30,000	$ 7,500	$ 109,455		0	3	2	0	0	0	0	0	0	2	7	1		8.5
E12	Information, Communications and Education	Education	Distribute NSW Maritime's 'Don't Make Waves' brochure to the boating community.	LGA-wide	All	NSW Maritime		C8		$ -	$ 7,500	$ 79,455		1	1	2	0	0	0	0	0	0	2	6	1		7.5
P60	Information, Communications and Education	Planning	Ensure that climate change considerations are incorporated into all relevant Plans of Management for locations around the Estuary.	LGA-wide	All	GCC	DECCW, CMA	E8, P42, W60	P43	$ 55,000	$ -	$ 55,000		0	0	2	4	4	0	0	0	0	3	13	2		16
R39	Information, Communications and Education	Research/Monitoring	Develop and maintain a database of all environmental and ecological data available for the Brisbane Water Estuary with a view to providing a comparison between present and historic Estuary conditions. This database should be regularly updated with the results of any monitoring undertaken. Long term trends should be identified and this information communicated directly to the public on a regular basis.	Catchment/Waterway-wide	All	GCC	CMA, DECCW	R38, R04		$ 20,000	$ 12,500	$ 152,425		3	3	3	3	0	0	0	0	0	4	16	1		17.5
P06	Sedimentary Processes	Planning	Develop an Entrance Management Policy for Brisbane Water to provide a strategic framework for the maintenance of navigation through the Estuary entrance.	Entrance	6	GCC	NSW Maritime	R09, R27, W18, W28	P07	$ 45,000	$ 2,500	$ 71,485		0	5	2	0	-1	0	4	0	2	2	14	2		17
P07	Sedimentary Processes	Planning	Based on our understanding of the ecological and physical processes operating within the Estuary, develop a channel layout for recreational and commercial boating usage which details current (and potential future) channel widths and depths to provide users of Brisbane Water with certainty while acknowledging the limitations of the Estuary. The channel layout should take into consideration environmental impacts and address the natural rates of sedimentary accretion in those locations.	Waterway-wide	All	GCC, LPMA	NSW Maritime	P06, R09, W18-W20, W25		$ 100,000	$ 4,000	$ 142,376		0	4	3	0	0	0	4	1	2	2	16	0		16
P14	Sedimentary Processes	Planning	Continue to enforce prohibition of mowing to the waters edge in both public and private foreshore areas in order to minimise foreshore erosion and impacts on estuarine vegetation.	Green Point	2	GCC		E09, R22		$ -	$ 15,000	$ 158,910		2	3	2	1	0	2	0	0	0	1	11	2		14
P12	Sedimentary Processes	Planning	Develop an Emergency Action Plan for Ettalong Beach in accordance with NSW Coastal Policy. The aim of the Plan should be to establish a framework for managing storm erosion events in a strategic fashion that considers public safety, public access and amenity, and ecological concerns. This option is dependent upon information provided in a Coastal Hazard Study.	Ettalong	6	GCC	DECCW	R11, W17, W28, W29, W55, W97, W112	P42, P43	$ 130,000	$ -	$ 130,000	NSW Coastal Management Program	0	3	0	3	0	1	3	0	0	0	10	2		13
P09	Sedimentary Processes	Planning	Implement tighter erosion and sedimentation controls to minimize risks to seagrass, with a priority for catchments adjacent to areas of seagrass of high value for species.	Catchment-wide	All	GCC	DII - Fisheries	C13, P18, P20, P21, P25, R20, W35		$ -	$ 25,000	$ 264,850		2	3	4	0	0	0	0	0	0	0	9	2		12
P13	Sedimentary Processes	Planning	Geomorphological assessment required to develop options to address the bank erosion occurring upstream of Ann Close Reserve on Narara Creek.	Narara	1	GCC			P01, W34	$ 45,000	$ -	$ 45,000		1	1	1	0	0	1	1	0	0	0	5	2		8
P11	Sedimentary Processes	Planning	Develop standard designs or guidelines for retaining walls to ensure consistent character and appearance across all locations for which they are necessary.	LGA-wide	All	GCC				$ 12,000	$ -	$ 12,000		0	2	2	0	0	1	0	0	0	0	5	1		6.5
P10	Sedimentary Processes	Planning	Develop planning controls specific to the foreshore running between Ettalong and Booker Bay to limit activities in the active coastal zone to those compatible with the observed cycles of sediment accretion and erosion.	East of Schnapper Road, Ettalong	6	GCC	DECCW	P12, P42, P52, R11, W28, W29, W55	P35, P43, P44	$ 30,000	$ -	$ 30,000		0	2	0	3	1	0	-1	-2	0	0	3	2		6
P08	Sedimentary Processes	Planning	Review and revise *DCP 145 Boating Facilities in St Hubert's Island Canals* to ensure consistency with the goals objectives of the Management Study and Plan. In particular, explicit consideration of sedimentary processes should form part of the assessment process for all development applications.	St Hubert's Island	4	GCC		W19, W35	R13	$ 15,000	$ -	$ 15,000		0	1	2	0	0	0	-1	0	0	0	2	2		5
R10	Sedimentary Processes	Research/Monitoring	Conduct a condition assessment of existing stormwater outlets draining into the Estuary focusing on assessing impacts on natural sedimentary processes (e.g. erosion, accretion) and adjacent habitats.	All foreshore areas	All	GCC		W27, W36, W51, W61-W64		$ 80,000	$ -	$ 80,000		3	3	3	3	0	0	0	0	0	0	12	1		13.5
R11	Sedimentary Processes	Research/Monitoring	Assess options for shoreline protection works that will seek to address the long-term erosion issues at Ettalong Beach.	Ettalong Beach	6	GCC	LPMA	P12, P43, W28, W29	P42	$ 80,000	$ -	$ 80,000	NSW Coastal Management Program	0	3	2	2	1	0	3	1	0	0	12	1		13.5
R09	Sedimentary Processes	Research/Monitoring	Conduct ongoing monitoring (by survey) of key navigation channels, including: - Entrance Channel, - Paddy's Channel, - Lintern Channel, - Woy Woy Channel, - Wagstaff Channel, - Cockle Channel, and - Saratoga Channel.	Waterway-wide	All	NSW Maritime		P06, P07, W18-W25		$ -	$ 7,500	$ 79,455		0	3	0	0	-1	0	4	3	0	0	9	2		12
R14	Sedimentary Processes	Research/Monitoring	Investigate options for replacing or modifying the existing seawall along Dane and Mason Parades with an environmentally friendly seawall. The options should aim to dissipate incoming waves and address erosion occurring at this location.	Gosford	2	GCC		E10, P48, W69		$ 60,000	$ -	$ 60,000	NSW Coastal Management Program	1	2	2	1	0	1	1	0	0	0	8	1		9.5
R13	Sedimentary Processes	Research/Monitoring	Audit foreshore structures such as boat ramps, seawalls and the like, in the canals of St Hubert's Island and identify those structures that are exacerbating erosion or accretion issues for other properties. Where feasible, require license holders for these structures to modify or retrofit problematic structures to mitigate these issues. Where possible, promote reinstatement of a natural vegetated shoreline. This may be achieved through the licensing/license renewal process.	St Hubert's Island	5	GCC	LPMA	C14, R31		$ 60,000	$ -	$ 60,000		1	2	3	0	0	0	0	0	0	0	6	2		9
R15	Sedimentary Processes	Research/Monitoring	Investigate options for addressing/managing subsidence currently occurring near Erina Creek.	Muloora Rd, Springfield	2	GCC		W34		$ 55,000	$ -	$ 55,000		1	1	0	0	0	0	1	0	0	0	3	2		6
R16	Sedimentary Processes	Research/Monitoring	Identify the cause of erosion under the bridge near Lara Street and outline measures to address this issue.	Park Bay	3	GCC		W34		$ 35,000	$ -	$ 35,000		1	1	1	0	0	0	0	0	0	0	3	2		6
R17	Sedimentary Processes	Research/Monitoring	Investigate options for implementation to address the erosion along Hardy's Bay Parade.	Killcare	6	GCC		W34		$ 220,000	$ 7,500	$ 299,455		1	1	1	0	0	0	0	0	0	0	3	2		6
R08	Sedimentary Processes	Research/Monitoring	For each significant dredging option considered for implementation, establish dredging trials to determine the effectiveness of proposed dredging activities.	Waterway-wide	All	LPMA, GCC	NSW Maritime	P07, R09, W18-W25		$ 120,000	$ -	$ 120,000		-1	3	-2	0	0	0	3	0	0	0	3	0		3
R12	Sedimentary Processes	Research/Monitoring	Examine the feasibility of regularly removing accumulated sediments from Fagan's Bay and Woy Woy Bay with a view to using these areas as sediment traps to prevent sediment accretion in the main waterbody of the Estuary.	Fagan's Bay, Woy Woy Bay	1, 3	GCC	LPMA			$ 42,000	$ -	$ 42,000		-1	1	3	0	0	0	0	1	0	0	4	-1		2.5
R07	Sedimentary Processes	Research/Monitoring	Undertake analysis incorporating radiocarbon dating of sediments associated with the mouth of Mudflat, RSL and Woy Woy Creeks to identify the rate of sedimentation.	Hardy's Bay, Woy Woy	All	GCC		W06, W27		$ 32,000	$ -	$ 32,000		0	2	0	0	0	0	0	0	0	0	2	0		2
W34	Sedimentary Processes	Works	Identify locations of bank erosion along creekline corridors and the Estuary foreshore. Design and implement remediation measures to address these issues, with re-establishment of native vegetation being the preferred option where feasible. Reference should be made to the shoreline assessment provided in Appendix H of the *Brisbane Water Estuary Processes Study* .	Erina Creek, Narara Creek, Woy Woy Creek, Hardy's Bay and Kincumber Creek as a priority	All	GCC	DWE, DECCW	P13, P14, R10, R17, W38, W41, W42, W45, W46, W48, W49, W53, W55		$ 200,000	$ 175,000	$ 2,053,952		3	4	4	1	1	1	2	0	0	0	16	2		19

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W29	Sedimentary Processes	Works	Replace the existing shoreline protection works (boulders) with a stepped, vegetated dune that provides for public access and amenity.	Ettalong Beach	6	GCC	DECCW, LPMA	P10, P12, W28, W55, W97, W112	P42, R11	$ 1,200,000	$ 15,000	$ 1,358,910	NSW Coastal Management Program	0	3	2	2	1	3	3	1	0	0	15	1		16.5
W26	Sedimentary Processes	Works	Rehabilitate the eroding foreshores on the eastern shores of Hardy's Bay with natural vegetation typical of that naturally occurring in the area.	Eastern shores of Hardy's Bay	6	GCC	Volunteers	E09, P49		$ 20,000	$ -	$ 20,000		2	4	3	2	0	2	0	0	0	0	13	1		14.5
W18	Sedimentary Processes	Works	Dredge the navigation channel up to 50,000m^3 in the Estuary entrance as a priority.	Entrance	6	LPMA, GCC	NSW Maritime	R08, R09, W28	P06	$ 850,000	$ 150,000	$ 2,439,102		-1	4	0	0	-1	0	4	3	0	0	9	2		12
W28	Sedimentary Processes	Works	Undertake beach re-nourishment works at Ettalong Beach. The use of sand dredged from the Ettalong Shoals should be considered for this option.	Ettalong Beach	6	GCC	LPMA	P10, P12, W29, W55, W97, W112	P42, R11	$ 50,000	$ 125,000	$ 1,374,252		-1	4	0	0	-1	0	4	3	0	0	9	2		12
W33	Sedimentary Processes	Works	Reinstate a vegetated, sandy shoreline at Pretty Beach similar to that present prior to the construction of Pretty Beach Road. The use of mangroves for revegetation works is discouraged due to their potential to outcompete and displace saltmarsh.	Pretty Beach	6	GCC	Volunteers	P49, W31, W32		$ 225,000	$ 6,000	$ 288,564		1	2	2	0	0	2	1	0	0	0	8	2		11
W27	Sedimentary Processes	Works	Undertake regular maintenance to remove sediments from the outlets of stormwater drains, starting with Hardy's Bay.	Catchment-wide	All	GCC		R10, W01		$ -	$ 50,000	$ 529,701		2	3	2	3	0	0	0	0	0	0	10	0		10
W35	Sedimentary Processes	Works	Design and construct appropriate sediment control works to address sediment accretion issues at St Hubert's Island.	St Hubert's Island	4	GCC		P08, R13, W19		$ 400,000	$ 15,000	$ 558,910		2	2	3	0	0	0	0	0	0	0	7	2		10
W38	Sedimentary Processes	Works	Implement shoreline protection works to address the erosion and foreshore inundation along the foreshore at Yattalunga Reserve.	Yattalunga	2	GCC			W34	Capital Works Program	$ -	N/A		1	1	2	1	0	0	1	0	0	0	6	2		9
W39	Sedimentary Processes	Works	Rehabilitate eroded foreshore near 29 Araluen Drive, Killcare.	Killcare	6	GCC			W34	$ 80,000	$ -	$ 80,000		1	1	2	1	0	0	1	0	0	0	6	2		9
W37	Sedimentary Processes	Works	Remove disused pipes, posts, debris and other rubbish from the intertidal portion of the mudflats adjacent to Victory Pde, Tascott.	Tascott	2	GCC		W36		$ 55,000	$ -	$ 55,000		1	1	2	0	0	1	0	0	0	0	5	2		8
W30	Sedimentary Processes	Works	Remove the sandstone and cement abutments from the Pretty Beach jetty and adjacent to the pool.	Pretty Beach	6	GCC		P39, W31		$ 500,000	$ -	$ 500,000		0	1	1	0	0	1	1	0	0	0	4	2		7
W46	Sedimentary Processes	Works	Investigate the cause of erosion around the Blackwall Point boat ramp and develop measures to address this issue. Any necessary repairs to stabilise the foreshore and the adjacent roadway should be undertaken.	Blackwall	4	GCC		W09, W34		$ 150,000	$ 10,000	$ 255,940		1	1	1	0	0	0	1	0	0	0	4	2		7
W55	Sedimentary Processes	Works	Identify the cause of foreshore erosion in Lance Webb Reserve and develop and implement measures to stabilise the foreshore.	Ettalong	6	GCC		W97, W112	P42, R11	$ 200,000	$ 7,500	$ 279,455	NSW Coastal Management Program	1	1	1	0	0	0	1	0	0	0	4	2		7
W41	Sedimentary Processes	Works	Undertake foreshore stabilisation works in the Punt Bridge area incorporating revegetation to address erosion issues.	East Gosford	2	GCC	Volunteers		W34	$ 100,000	$ 10,000	$ 205,940		1	1	1	0	0	1	1	0	0	0	5	1		6.5
W47	Sedimentary Processes	Works	Seek to remediate scouring currently occurring behind the existing seawall in Illoura Reserve. This may necessitate replacement of the existing seawall with a new, environmentally friendly seawall structure. Consideration should also be directed to the principles of "Safety by Design" to manage vandalism.	Davistown	5	GCC		W48, W56	W34	$ 500,000	$ 12,500	$ 632,425		1	2	1	0	0	0	1	0	0	0	5	1		6.5
W114	Sedimentary Processes	Works	Dredge to improve access to the Volunteer Coastal Patrol in the region of the boat ramp and surrounds. The dredging should be sufficient to permit access over the full tidal cycle.	Point Clare	2	GCC	NSW Maritime, LPMA	R08		$ 170,000	$ -	$ 170,000		-1	1	0	0	0	0	3	0	0	0	3	2		6
W40	Sedimentary Processes	Works	Restore flows to Woy Woy Creek by de-commissioning the dam at the former abattoir site with a view to providing for natural scouring of the creek channel.	Woy Woy	3	GCC		W59		$ 120,000	$ -	$ 120,000		1	1	0	1	0	0	0	0	0	0	3	2		6
W51	Sedimentary Processes	Works	Implement measures to dissipate the energy of stormwater flows and prevent scour associated with the stormwater outlet near the corner of Jirramba and Mimosa Avenues.	Saratoga	2	GCC		W01	R10, W34	$ 55,000	$ -	$ 55,000		1	1	1	0	0	0	0	0	0	0	3	2		6
W53	Sedimentary Processes	Works	Undertake bank stabilisation works to address the erosion occurring in the creek in the region of Avoca Drive and Sun Valley Drive.	Green Point	2	GCC			W34	$ 160,000	$ 5,000	$ 212,970		1	1	1	0	0	0	0	0	0	0	3	2		6
W42	Sedimentary Processes	Works	Undertake foreshore stabilisation works to address erosion currently occurring near Goondi Close.	Horsfield Bay	3	GCC			W34	$ 80,000	$ 5,000	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W45	Sedimentary Processes	Works	Undertake foreshore stabilisation works to address erosion currently occurring in Palermo Reserve, Empire Bay Drive.	Daleys Point	4	GCC			W34	$ 80,000	$ 5,000	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W48	Sedimentary Processes	Works	Implement foreshore stabilisation works to prevent further erosion of the Illoura Reserve foreshore between Lintern Street and 28 Molinya Road.	Davistown	5	GCC	Volunteers	W47, W56	W34	$ 80,000	$ 5,000	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W49	Sedimentary Processes	Works	Implement foreshore stabilisation works to prevent further erosion of the shoreline near Rip Road reserve.	Blackwall	4	GCC	Volunteers		W34	$ 80,000	$ 5,000	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W43	Sedimentary Processes	Works	Develop and implement a long term solution to replace the currently failing seawall in Lions Memorial Park on Brick Wharf Road. Any option identified should wherever possible incorporate environmentally friendly features.	Woy Woy	4	GCC	DECCW	P62, W80	W34	$ 500,000	$ 15,000	$ 658,910		1	1	1	0	0	1	1	0	0	0	5	0		5
W115	Sedimentary Processes	Works	Dredge to improve access to the boat pump-out and other facilities in Gosford Harbour. The dredging should be sufficient to permit access over the full tidal cycle.	Gosford Harbour	2	GCC	LPMA	R08		$ 170,000	$ -	$ 170,000		-1	1	0	0	0	0	3	0	0	0	3	1		4.5
W21	Sedimentary Processes	Works	Dredge from the Correa Bay boat ramp to the entrance of Woy Woy Creek, to extend 300m up the creek channel, with a view to improving drainage and access at this location.	Woy Woy	3	LPMA, GCC	NSW Maritime	R08		$ 500,000	$ -	$ 500,000		-1	1	1	1	0	0	1	0	0	0	3	1		4.5
W22	Sedimentary Processes	Works	Dredge from Bulls Hill to Correa Bay to remove sediment that has been deposited there in the last few years.	Woy Woy	3	LPMA, GCC		W04		$ 500,000	$ -	$ 500,000		-1	1	1	1	0	0	1	0	0	0	3	1		4.5
W44	Sedimentary Processes	Works	Replace collapsed stormwater drain running between the two ovals in Austin Butler Reserve and remove accreted sediments. There is a preference for the use of a natural vegetated swale and/or small wetland.	Woy Woy	4	GCC				$ 100,000	$ -	$ 100,000		1	1	-1	1	0	0	1	0	0	0	3	1		4.5
W52	Sedimentary Processes	Works	Investigate and implement measures to address siltation currently occurring in the open drain along the foreshore between Mundoora Access and Wilkie King Avenue. Both removal of the accreted sediments and measures to address sediment sources should be considered. There is a preference for the use of a natural vegetated swale and/or small wetland.	Yattalunga	2	GCC		W01	R10	$ 80,000	$ 5,000	$ 132,970		1	1	1	0	0	0	0	0	0	0	3	1		4.5
W119	Sedimentary Processes	Works	Extend dredging of the Entrance Reach further upstream past Kourung Gourung Point between Ettalong Beach and Pretty Beach with a view to improving navigation.	Entrance	6	GCC	LPMA	R08, R09	P06, P07	$ 500,000	$ 100,000	$ 1,559,401		-1	2	-1	0	-1	0	2	0	0	0	1	2		4
W120	Sedimentary Processes	Works	Dredge to improve access to the boat pump-out and other facilities in Hardy's Bay. The dredging should be sufficient to permit access over the full tidal cycle.	Hardy's Bay	6	GCC	LPMA	R08		$ 200,000	$ -	$ 200,000		0	1	0	0	0	0	1	0	0	0	2	1		3.5
W23	Sedimentary Processes	Works	Deepen and widen the outlets of Mudflat and RSL Creeks in Hardy's Bay so that both creeks restore tidal flushing. The efficacy of this option in improving flushing should be assessed prior to undertaking the works.	Mudflat and RSL Creeks	6	LPMA, GCC		R07, W06, W27, W34		$ 160,000	$ -	$ 160,000		-1	1	1	1	0	0	0	0	0	0	2	1		3.5
W54	Sedimentary Processes	Works	Investigate and implement measures to address the eroding seawall located near Araluen Drive on the southern side of Hardy's Bay. Preferred options include re-establishment of native vegetation or an environmentally friendly seawall.	Hardy's Bay	6	GCC			W34	$ 320,000	$ 10,000	$ 425,940		0	1	1	0	0	0	0	0	0	0	2	1		3.5
W19	Sedimentary Processes	Works	Undertake an ongoing program of maintenance to restore the drainage canals of St Hubert's Island to their original design criteria.	St Hubert's Island	4	GCC		R08, R09		$ 750,000	$ 125,000	$ 2,074,252		-1	2	-2	0	0	0	1	0	0	0	0	2		3
W31	Sedimentary Processes	Works	Remove accreted sediments from the eastern shoreline along Pretty Beach, including those that have built up in the swimming pool.	Pretty Beach	6	GCC		P39, W30, W32		$ -	$ 25,000	$ 264,850		-1	1	2	0	0	0	1	0	0	0	3	0		3

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W32	Sedimentary Processes	Works	Dredge sediments around the boat launching pontoon at Pretty Beach to enable boats to tie up on both sides of the pontoon.	Pretty Beach	6	GCC		W31, W33		$ 55,000	$ 120,000	$ 1,326,282		-1	1	2	0	0	0	1	0	0	0	3	0		3
W116	Sedimentary Processes	Works	Dredge to improve navigation and access to boat ramps in Cockle Channel.	Davistown	5	GCC	LPMA	R08, R09	P07	$ 250,000	$ 37,500	$ 647,276		-1	1	0	0	0	0	1	0	0	0	1	1		2.5
W117	Sedimentary Processes	Works	Dredge to improve navigation in Woy Woy Channel near Pelican Island.	Woy Woy	4	GCC	LPMA	R08, R09	P07	$ 250,000	$ 37,500	$ 647,276		-1	1	0	0	0	0	1	0	0	0	1	1		2.5
W36	Sedimentary Processes	Works	Dredge built-up sand associated with the stormwater outlet between 29-33 Victory Pde, Tascott.	Tascott	2	LPMA, GCC		W34, W37, W101		$ 120,000	$ -	$ 120,000		-1	1	1	1	0	0	0	0	0	0	2	0		2
W25	Sedimentary Processes	Works	Dredge in the Saratoga (Paddy's and Lintern) Channel(s) and around the boat ramps to permit better access.	Saratoga and Green Point	2	LPMA, GCC	NSW Maritime	R08, R09		$ 600,000	$ -	$ 600,000		-1	1	-1	0	0	0	1	0	0	0	0	1		1.5
W50	Sedimentary Processes	Works	Undertake minor dredging works to improve access to the Centennial Street boat ramp.	Saratoga	4	GCC				$ 80,000	$ -	$ 80,000		-1	1	-1	0	0	0	1	0	0	0	0	1		1.5
W118	Sedimentary Processes	Works	Dredge to improve navigation in Woy Woy Bay.	Woy Woy Bay	3	GCC	LPMA	R08		$ 200,000	$ -	$ 200,000		-1	1	0	0	0	0	1	0	0	0	1	0		1
W20	Sedimentary Processes	Works	Dredge the sand bars in the channel between Blackwall Point and Allfield Road, Woy Woy, with a view to improving navigation.	Woy Woy	3	LPMA, GCC	NSW Maritime	R08		$ 360,000	$ -	$ 360,000		-1	1	-2	0	0	0	1	0	0	0	-1	1		0.5
W24	Sedimentary Processes	Works	Deepen and widen the entrance to Hardy's Bay to permit greater tidal flushing. The efficacy of this option in improving flushing should be assessed prior to undertaking the works. In addition, the environmental aspects must also be considered.	Hardy's Bay	6	LPMA, GCC		R08		$ 500,000	$ -	$ 500,000		-1	2	-2	0	0	0	1	0	0	0	0	0		0
W121	Sedimentary Processes		Investigate options to address access and amenity issues associated with the blockage of the entrance to Riley's Bay and sediment accretion in this area.	Riley's Bay	6	GCC	LPMA	R08		$ 50,000	$ -	$ 50,000		-1	1	0	0	0	0	1	0	0	0	1	0		1
P32	Visual Amenity and Landscape Character	Planning	Develop a policy for the preservation of iconic views around the Estuary and its catchment.	Waterway-wide/Catchment-wide	All	GCC		C05	R30	$ 15,000	$ -	$ 15,000		0	0	0	0	4	5	0	0	0	0	9	0		9
R30	Visual Amenity and Landscape Character	Research/Monitoring	Undertake a visual assessment of the Brisbane Water Estuary and identify important landscape types and iconic views.	Waterway-wide/Catchment-wide	All	GCC		P32		$ 80,000	$ -	$ 80,000		0	0	0	0	4	5	0	0	0	0	9	0		9
C01	Water and Sediment Quality	Compliance	Establish a program of auditing to ensure best management practices for marinas around Brisbane Water Estuary. DECCW's brochure Environmental Action for Marinas, Boatsheds and Slipways should be provided to marine operators.	All marinas	All	DECCW, NSW Maritime				$ 20,000	$ 30,000	$ 337,820		3	2	3	0	0	1	3	0	0	2	14	0		14
C02	Water and Sediment Quality	Compliance	Provide additional resources for Council officers to undertake audits of properties to ensure enforcement of policies and conditions of consent relating to water quality during both the construction and operational phases.	Catchment-wide	All	GCC		C13, P04		$ -	$ 70,000	$ 741,581		3	3	3	0	0	0	0	0	0	0	9	2		12
C03	Water and Sediment Quality	Compliance	Work with private land holders / tenants to improve stormwater management practices in the industrial estate near Hawke Street.	Kincumber	5	GCC	DECCW			$ 15,000	$ -	$ 15,000		2	2	1	0	0	1	1	0	0	1	8	1		9.5
P04	Water and Sediment Quality	Planning	Review and revise *DCP 165 - Water Cycle Management* to reflect current best practice.	LGA-wide	All	GCC		C02, C13, P43, W58		$ 40,000	$ -	$ 40,000		4	2	4	4	0	0	2	1	0	0	17	2		20
P01	Water and Sediment Quality	Planning	Provide for the development, implementation and regular re-assessment of Riparian Zone and Bank Management Plans for the major tributaries draining into the Estuary, including Narara Creek, Erina Creek, Kincumber Creek (Riparian Plan already in place), Woy Woy Creek and Ettalong Creek.	Catchment-wide	All	GCC	DWE	P13, W34, W53		$ 250,000	$ 125,000	$ 1,574,252		4	3	4	1	0	2	0	0	0	0	14	2		17
P02	Water and Sediment Quality	Planning	Develop and implement a pollution response strategy to address major pollution events. Policy *D1.02 - Oil Spillages in Navigable Waters* should be updated accordingly.	Waterway-wide	All	GCC	DECCW, NSW Maritime	C01, E11		$ 25,000	$ -	$ 25,000	National Natural Disaster Mitigation Program	2	0	5	0	0	0	2	0	0	0	9	1		10.5
P05	Water and Sediment Quality	Planning	Investigate the need for sediment traps and other stormwater management measures to control any erosion and sedimentation from sloping lands draining to the stormwater outlet opposite Byalla Lane.	Saratoga	2	GCC			R24, W01	$ 17,500	$ -	$ 17,500		1	1	1	0	0	0	1	0	0	0	4	1		5.5
P03	Water and Sediment Quality	Planning	Investigate option of prohibiting 2-stroke outboard motors.	Waterway-wide	All	NSW Maritime	GCC			$ 10,000	$ -	$ 10,000		2	0	2	0	0	0	-5	0	0	0	-1	0		-1
R02	Water and Sediment Quality	Research/Monitoring	Ensure ongoing monitoring of the water and sediment quality of the Brisbane Water Estuary for the purposes of recreational usage and ecological health.	Waterway-wide	All	GCC	CMA	R37, R38, R40	R01	$ -	$ 220,000	$ 2,330,683		5	0	3	0	0	0	4	1	1	3	17	2		20
R06	Water and Sediment Quality	Research/Monitoring	Undertake ongoing monitoring and maintenance of Council owned stormwater quality improvement devices.	Catchment-wide	All	GCC		R02, R04, R05		Capital Works Program	$ -	N/A		5	2	3	1	0	0	2	0	0	0	13	2		16
R01	Water and Sediment Quality	Research/Monitoring	Conduct a review of the design and methodology employed in the existing water quality monitoring program. Ideally the program should be a comprehensive, scientifically rigorous and ongoing program of water and sediment quality monitoring for the Brisbane Water Estuary, incorporating dry weather and event monitoring of both the tributary mouths and main waterbody. Sampling in the main waterbodies should incorporate vertical profiling.	Catchment/Waterway-wide	All	GCC	CMA	R37, R38, R40		$ 35,000	$ -	$ 35,000		4	0	3	0	0	0	3	0	0	1	11	2		14
R04	Water and Sediment Quality	Research/Monitoring	Audit the performance of existing stormwater quality improvement devices and assess the need for modifications.	Catchment-wide	All	GCC		R05, R24, W01		$ 32,000	$ -	$ 32,000		3	3	4	0	0	0	0	0	0	0	10	2		13
R03	Water and Sediment Quality	Research/Monitoring	Calculate a nutrient budget for the Estuary to assess the potential for eutrophication of the more enclosed portions of the waterway. The analysis should assess current conditions and conditions under climate change scenarios. Reference should be made to the water quality modelling undertaken for the Estuary as a whole, as outlined in Appendix E of the *Brisbane Water Estuary Processes Study* .	Waterway-wide	All	DECCW	GCC	W11, W12, W24	R03	$ 20,000	$ -	$ 20,000		4	0	4	0	0	0	1	0	0	0	9	1		10.5
R05	Water and Sediment Quality	Research/Monitoring	Keep a log of the volumes and types of material removed from GPTs during routine maintenance and incorporate this information into the water quality monitoring program.	Catchment-wide	All	GCC		R02, R06, R04		$ -	$ 6,000	$ 63,564		3	0	3	0	0	0	0	0	0	0	6	2		9
W01	Water and Sediment Quality	Works	Investigate options for implementing catchment based WSUD features in the catchment in order to manage stormwater quality and quantity, with a priority focus on the Narara and Erina Creek catchments, followed by Kincumber Creek catchment.	Catchment-wide	All	GCC		P05, R04-R06, R24, W04, W06, W07, W10, W13, W14		$ 60,000	$ 65,000	$ 748,611		5	4	5	0	0	1	2	1	0	0	18	2		21
W03	Water and Sediment Quality	Works	Provide for continued implementation of Council's Sewerage Enhancement Program and associated capital investments.	Catchment-wide	All	GCC				Sewerage Enhancement and Capital Works	$ -	N/A		4	0	4	0	0	0	4	1	0	0	13	1		14.5
W02	Water and Sediment Quality	Works	Install additional sewage pump-out facilities to reduce water pollution. These should be situated at locations accessible by a range of vessels.	Waterway-wide	All	NSW Maritime		E11, P55, W81		$ 100,000	$ 50,000	$ 629,701	NSW Maritime Better Boating Program (up to 50%)	4	0	3	0	0	0	4	0	0	0	11	1		12.5
W11	Water and Sediment Quality	Works	Install an additional opening/culvert under the Brisbane Water Drive causeway with a view to increasing flushing of Woy Woy Inlet and Woy Woy Bay and promoting scouring of the adjacent navigational channels. This option will require detailed investigations to confirm the feasibility and long term sustainabilityprior to proceeding with implementation.	Woy Woy	3	GCC	RailCorp	W12		$ 500,000	$ -	$ 500,000		2	2	1	1	0	0	1	0	0	0	7	0		7
W08	Water and Sediment Quality	Works	Provide more regular street cleaning to capture rubbish before it makes its way into the waterways.	Catchment-wide	All	GCC		C15, W93		$ -	$ 35,000	$ 370,790		3	0	2	0	0	1	1	0	0	0	7	2		10
W12	Water and Sediment Quality	Works	Provide for ongoing maintenance of the opening(s) under the Brisbane Water Drive causeway to prevent siltation and maintain flushing.	Woy Woy	3	GCC		W11		$ -	$ 12,500	$ 132,425		2	1	2	1	0	0	1	0	0	0	7	2		10
W04	Water and Sediment Quality	Works	Provide additional sediment traps for locations draining to Correa Bay. Sediment traps should target catchment inflows from the Bulls Hill Quarry and Garbage tip.	Correa Bay	3	GCC		W01, W22		$ 100,000	$ 7,500	$ 179,455		2	1	2	0	0	0	1	0	0	0	6	1		7.5
W06	Water and Sediment Quality	Works	Install and maintain as required sediment traps targeting stormwater flows draining from the escarpment at Hardy's Bay.	Hardy's Bay	6	GCC		W01		$ 100,000	$ 6,000	$ 163,564		2	1	2	0	0	0	1	0	0	0	6	1		7.5
W07	Water and Sediment Quality	Works	Provide ongoing maintenance of existing sediment traps in locations draining to Horsfield Bay.	Horsfield Bay	3	GCC		W01		$ -	$ 6,000	$ 63,564		2	1	2	0	0	0	1	0	0	0	6	1		7.5

Option ID	Management Goal Addressed	Management Category	Strategy Outline	Location	Zone	Primary Responsibility	Secondary Responsibility	Cross Reference with Option:	Dependency on Option:	Preliminary Indicative Estimate of Capital Cost	Preliminary Indicative Estimate of Annual Maintenance/ Recurrent Cost/ Revenue (-ve values)	Net Present Value	Potential Funding Stream	Water & Sediment Quality	Sedimentary Processes	Ecological Processes	Foreshore Flooding / Inundation	Cultural Heritage	Visual Amenity	Recreational Usage	Development	Governance	Information, Communications and Education	Raw Benefit Index	Council / DECCW Response	Community Response	Adjusted Benefit Index
W05	Water and Sediment Quality	Works	Advertise and provide signage for boat pump-out facilities.	Gosford, Hardy's Bay	2, 6	NSW Maritime		E11, P55, W02, W81		$ 17,500	$ 5,000	$ 70,470		3	0	2	0	0	0	2	0	0	0	7	0		7
W17	Water and Sediment Quality	Works	Implement a program of maintenance to address the accumulation of litter in the open drain near Beach Street. Long term management of this issue should also be considered, for example, public education and/or the implementation of additional gross pollutant traps.	Ettalong	6	GCC		C15, W01		$ 75,000	$ 6,000	$ 138,564		1	0	1	0	0	1	1	0	0	1	5	1		6.5
W10	Water and Sediment Quality	Works	Remediate (or pipe) open drains and install sediment traps for those drains running from Wilkie King Ave and Mundoora Ave, Yattalunga.	Yattalunga	2	GCC		W01		$ 75,000	$ 6,500	$ 143,861		2	1	1	0	0	0	0	0	0	0	4	1		5.5
W13	Water and Sediment Quality	Works	Develop and implement measures to address stormwater quality issues associated with runoff from fire trails on Blackwall Mountain.	Blackwall	4	GCC	DECCW	W01, R24		$ 75,000	$ 6,000	$ 138,564		1	2	1	0	0	0	0	0	0	0	4	1		5.5
W14	Water and Sediment Quality	Works	Develop and implement measures to address stormwater quality issues associated with runoff from the access road and fire trails near Fisherman's Parade.	Daleys Point	6	GCC	DECCW	W01, R25		$ 75,000	$ 6,000	$ 138,564		1	2	1	0	0	0	0	0	0	0	4	1		5.5
W15	Water and Sediment Quality	Works	Seal the Hawke Street car park to prevent erosion into Kincumber Creek. The use of permeable pavement is recommended over impermeable surfaces.	Kincumber	5	GCC		W01, R26		$ 100,000	$ 6,000	$ 163,564		1	1	1	0	0	1	0	0	0	0	4	1		5.5
W16	Water and Sediment Quality	Works	Investigate and implement measures to improve flow/drainage in the open channel near Mundoora Avenue.	Yattalunga	2	GCC				$ 150,000	$ -	$ 150,000		1	1	1	1	0	0	0	0	0	0	4	1		5.5
W09	Water and Sediment Quality	Works	Provide kerb and guttering for those roads that are currently unsealed/unfinished.	Woy Woy, Blackwall	All	GCC				$ 1,200,000	$ 35,000	$ 1,570,790		2	2	-4	-1	0	1	0	1	0	0	1	1		2.5

Appendix F

Catchment Modelling Report

Cardno LawsonTreloar

Shaping the Future

Brisbane Water Estuary Management Study

MUSIC Catchment Modelling

Revised Draft

LJ2717/R2596V2

Prepared for Gosford City Council*

12 November 2009

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Cover Photo: Koolewong Foreshore Reserve, Brisbane Water Drive. Photo taken during site inspections in June 2009.

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Glossary and Abbreviations

BASIX	Building Sustainability Index
BoM	Bureau of Meteorology
CDS	Continuous Deflective Separation
CRC	Cooperative Research Centre
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DECC	Department of Environment and Climate Change (now DECCW)
DECCW	Department of Environment, Climate Change and Water (formerly DECC)
EMS	Estuary Management Study
GCC	Gosford City Council
GPT	Goss Pollutant Trap
LGA	Local Government Area
MHL	Manly Hydraulics Laboratory
PET	Potential Evapotranspiration
SMCMA	Sydney Metropolitan Catchment Management Authority
TN	Total Nitrogen
TP	Total Phosphorous
TSS	Total Suspended Solids
WAE	Work-as-Executed
WSUD	Water Sensitive Urban Design

1 Introduction

A MUSIC water quality model was established for Brisbane Water as part of the *Brisbane Water Estuary Processes Study* (Cardno, 2008). This MUSIC model formed the basis for subsequent modelling of five Scenarios, as described below, conducted as part of the Brisbane Water Estuary Management Study (EMS).

This report follows the following structure:

Section 2 gives an overview of the establishment of the MUSIC water quality model for the *Brisbane Water Estuary Processes Study* (Cardno, 2008).

Sections 3 to **7** detail MUSIC model Scenarios 1 to 5 respectively, which were developed to support the options assessment process within the Brisbane Water EMS. The five scenarios are as follows:

- *Scenario 1* incorporates Gross Pollutant Traps (GPTs) into the existing MUSIC model to simulate present day catchment conditions, with existing treatment devices;
- *Scenario 2* models predicted 2030 catchment conditions based on the assumption of a 25% intensification by area of residential zones within the Woy Woy and Gosford areas. Scenario 2 also incorporates one known 'greenfield' development area, which is the proposed industrial development at Somersby. All new development would involve rainwater tanks and generic treatment devices to meet Council's stormwater treatment requirements contained in the *Water Cycle Management Guidelines* (GCC, 2007);
- *Scenario 3* updates the generic treatment devices performance incorporated in Scenario 2 with DECC's proposed stormwater treatment targets in *Managing Urban Stormwater: Environmental Targets* (DECC and SMCMA, 2007); load reductions of TSS, TP and TN by 85%, 65% and 45% respectively;
- *Scenario 4* incorporates regional treatment devices into the Scenario 3 model, representing an 'ultimate development scenario' in 2030. Treatment devices considered include GPTs, Bioretention Systems and Rainwater Tanks for reuse, which are all Water Sensitive Urban Design (WSUD) features aimed at reducing pollutant loads in the stormwater. These regional treatment devices have been cross-referenced based on those management options relating to water and sediment quality, presented in the Brisbane Water EMS; and
- *Scenario 5* incorporates the top five most effective regional treatment devices, selected from the full suite of devices modelled in Scenario 4. Council could realistically implement these top five devices in the next five to ten years, with beneficial impacts on the overall water quality of Brisbane Water and its associated major tributaries.

Section 8 presents the results of all five Scenarios.

Section 9 discusses and concludes the outcomes of all five Scenarios and relates the implications of these results to the DELFT3D modelling undertaken for the *Brisbane Water Estuary Processes Study* (Cardno, 2008).

2 MUSIC Water Quality Model

A MUSIC model for Brisbane Water was developed and verified as part of the *Brisbane Water Estuary Processes Study* (Cardno, 2008), to model pollutant loads in the stormwater for the Brisbane Water catchment. The following three pollutants, considered key stressors for aquatic habitats, were modelled:

- Total suspended solids (TSS);
- Total phosphorous (TP); and
- Total nitrogen (TN).

For full details of the MUSIC model refer to Appendix B of the *Brisbane Water Estuary Processes Study* (Cardno, 2008), which contains the catchment modelling report *Brisbane Water Estuary Processes Study, Catchment Modelling – MUSIC, Appendix B* (Cardno, 2007).

2.1 Model Development

Climate data sources included rainfall data sourced from Manly Hydraulics Laboratory (MHL) and rainfall and monthly potential evapotranspiration (PET) data sourced from the Bureau of Meteorology (BoM). This data was analysed to determine the average (50 percentile), dry (lower 10 percentile) and wet (upper 10 percentile) rainfall conditions. Three conditions were modelled for the Estuary Processes Study to establish loads under current conditions (a baseline); the representative average, wet and dry rainfall years. Only the representative average rainfall year (1995) has been considered for further modelling undertaken as part of this report.

The Brisbane Water catchment was broken up into 233 sub-catchments based on hydrological and land use considerations (**Figure 1**). The area in hectares and impervious percentage was defined for each sub-catchment, as provided in Cardno (2007).

There are a number of tributaries that enter Brisbane Water, with the six major tributaries being Narara, Erina, Kincumber, Woy Woy, Coorumbine and Ettalong Creeks (**Figure 1**).

2.2 Results and Outcomes

Results obtained from the baseline MUSIC model are shown in **Table 2.1**.

Table 2.1: Baseline Conditions – Annual Loads for Representative Average Year (1995)

Location	Area (ha)	Annual Flow (ML/yr)	Runoff Coefficient	Annual Loads (kg/yr)		
				TSS	TP	TN
Upper Narara	2811	8920	0.26	831000	1810	15000
Lower Narara	4565	16800	0.30	1680000	3820	30600
Upper Erina	1926	4370	0.18	246000	541	5420
Lower Erina	3252	9310	0.23	774000	1860	15500
Kincumber Creek	484	2050	0.34	238000	604	4540
Woy Woy Creek	588	1760	0.24	167000	260	2470
Ettalong Creek	780	3350	0.35	348000	981	7080
Coorumbine Creek	361	1450	0.33	160000	329	2710
Direct to Brisbane Water*	1699	10490	0.50	1216000	3795	25680
Total Catchment	**16466**	**58500**	**0.29**	**5660000**	**14000**	**109000**

* The pollutant loads and flow delivered directly to Brisbane Water have been back-calculated as the difference between 'Total Catchment' pollutant loads in Brisbane Water and the sum of pollutant loads from the major tributaries as listed in **Table 2.1**and reported in Cardno (2008). MUSIC reports all outputs rounded to three significant figures; hence it should be noted that this back-calculation method may incur slight errors due to rounding.

Key outcomes of the comprehensive catchment modelling were:

- Narara Creek was shown to deliver a large proportion of the pollutant load entering the Brisbane Water Estuary; approximately 42% (averaged over TSS, TP and TN loads). This is a function of the larger size of its catchment and also the development within its catchment.
- By comparison, Erina Creek is well developed in the lower reaches of the catchment, while the upper catchment is largely rural and forested. As a result, Erina Creek produces less than half the pollutant loads of Narara Creek; approximately 18%.
- The smaller major tributaries including Kincumber, Woy Woy, Ettalong and Coorumbine Creeks contribute a much smaller proportion of the pollutant load entering the Brisbane Water, totalling approximately 16%.
- The sub-catchments that drain directly to the Brisbane Water Estuary represent approximately 24% of the total pollutant load that enters the Estuary, which is quite a substantial proportion. A number of these sub-catchments comprise highly developed, water-front land. This situation results in a higher proportion of impervious area, and hence greater runoff and associated pollutant loads.
- In terms of pollutant load intensity, Kincumber Creek produces a greater pollutant load per hectare than the other major tributaries of Brisbane Water. Kincumber Creek has a mixture of industrial and residential areas, all of which have high proportions of impervious area. Similarly, Ettalong Creek, with runoff sourced from some of the highly developed Woy Woy area, has high pollutant load intensity. The sub-catchments that drain directly to Brisbane Water, however, have the highest pollutant load intensities.
- The pollutant load intensities from Woy Woy Creek and Upper Erina Creek are low when compared with the rest of the sub-catchments. Both of these catchments have a low proportion of impervious areas, and as a result, a reduction in runoff. Furthermore, Woy Woy Creek has a high proportion of forested area, which naturally has lower stormwater pollutant concentrations.

3 Scenario 1 - Gross Pollutant Traps

3.1 Data Sources

Gross Pollutant Trap (GPT) data and GIS layers were provided by Gosford City Council to assist with schematising the Scenario in the model. A list of 103 existing GPTs in the LGA area was provided by Council.

This list was refined by excluding GPTs not within the bounds of the Brisbane Water Catchment (i.e. the study area defined in **Figure 1**), and excluding those GPTs which only capture gross pollutants and do not generally achieve any reduction in TSS, TN or TP loads, including:

- Ecosol Pit Baskets;
- Steel Pratten Traps;
- Nettechs;
- Floating Booms; and
- Tidal Gates.

3.1.1 GPT Type and Location

After refinement, as discussed above, 11 GPTs were incorporated into the MUSIC model. These included the following types of proprietary GPT devices:

- Humeceptors;
- Humegards;
- CDS Units;
- Rocla Unit (assumed to be a CleansAll); and
- Ecosol Solid Pollutant Filter RSF 4000.

Other treatment systems, such as wetlands, sediment basins, bioswales etc are not listed in Council's records of treatment devices and therefore only GPTs (as provided by Council) have been included in the Scenario 1 model.

Relevant details regarding location and type of GPT, as provided by Gosford City Council, are given in **Table 3.1**.

Table 3.1: GPT Type and Location

Council Asset Number	Device Type	Number of Units	Catchment	Suburb	Street	Locality Description	Outlet Type	Outlet Size (mm)
GPT 9	Humeceptor	1	Narara Creek	West Gosford	Manns Rd near Yandina Rd	Grass in front of Isuzu Trucks near Yandina Rd	*	*
GPT 10	Humeceptor	1	Cockle Broadwater	Kincumber	Opp No.1 Kerta Rd cnr Hawke St	On the road	*	*
GPT 11	Humegard	1	Cockle Broadwater	Kincumber	Cnr Kerta Rd & Empire Bay Dr	On grass area above the shops	*	*
GPT 13	CDS	1	Woy Woy Peninsula	Blackwall	Lalina Ave	Off the road, southern end of Council's pathway	*	*
GPT 15	Rocla Unit	1	Woy Woy Peninsula	Ettalong Beach	Schnapper Rd	Near toilet block	*	*
GPT 18	Ecosol Solid Pollutant Filter RSF 4000	1	Woy Woy Peninsula	Umina Beach	Melbourne Ave	Carpark near tennis club	Pipe	900
GPT 20	CDS	1	Erina Creek	Erina Heights	Carlton Rd	Carlton Rd footpath near The Entrance Rd roundabout	*	*
GPT 21	Humeceptor	1	Erina Creek	Erina Heights	The Entrance Rd	Off Serpentine Rd	*	*
GPT 22	CDS	1	Erina Creek	Erina Heights	The Entrance Rd	472 The Entrance Rd	*	*
GPT 23	Humegard	2	Narara Creek	Wyoming	Pacific Hwy	In the vicinity of the culvert bridge near Willows Motor Inn	*	*
GPT 24	Humegard	1	Erina Creek	Springfield	Cobbedah Dr	Corner Noorumba Rd beyond wet detention basin	*	*

* Not specified in Council records.

3.2 GPT Catchment Areas

The locations of the 11 GPTs within their respective MUSIC sub-catchments were assessed in relation to the sub-catchment pipe drainage, distance to the overall sub-catchment outlet location and direction of surface flow. Based on this assessment, and in the absence of design data and work-as-executed (WAE) drawings for the GPTs, individual GPT catchment areas where defined. These catchment or treatment areas are shown in **Figure 2**. The sizes of the GPT catchment areas, as shown in **Figure 2**, are given in **Table 3.2**.

Table 3.2: GPT Catchment Areas and MUSIC Source Nodes

Council Asset Number	Sub-Catchment Treated	GPT Catchment Areas (ha)*
GPT 9	W_Gosford6(b)	12
GPT 10	Kincumber4(b)	7
GPT 11	Kincumber5(b)	9
GPT 13	Woy_P8(b)	111
GPT 15	Woy_P10(b)	19
GPT 18	Umina1(b)	3
GPT 20	Erina_Ck1(b)	24
GPT 21	Erina_Ck3(b)	2
GPT 22	Chetwynd1(b)	2
GPT 23 (2 Units)	Wingello1(b)	4
GPT 24	Chertsey5(b)	11

* Assumptions were made regarding the treatment catchment size due to the absence of WAE drawings.

3.3 GPT Treatment Efficiency Details

The performance data and pollutant treatment efficiencies of each GPT device type as input into MUSIC, derived from technical manuals for the products or otherwise assumed as indicated, are given below in **Table 3.3**.

Table 3.3: MUSIC Input Parameters for GPT Treatment Efficiencies

Parameter	GPT Device Type				
	Humeceptor	Humegard	CDS Unit	Rocla CleansAll Unit	Ecosol Solid Pollutant Filter RSF 4000
Low Flow By-pass (m^3/s)	0*	0*	0*	0*	0
High Flow By-pass (m^3/s)	0.2*	0.4*	0.4*	0.48†	0.485^
TSS Reduction	80%	85%	70% (between 75 and 700mg/L)	70%	91%
TP Reduction	30%	0%	30% (between 0.5 and 4.5mg/L)	0%*	30%
TN Reduction	30%	0%	0%	0%*	13%
Performance Data Source(s)	Humes, 2007	Humes, 2008	Rocla and CRC for Catchment Hydrology, 2005	Rocla, 2002 and University of South Australia, 1998	Ecosol and Ecosol, 2006

* These values have been assumed.

† Based on a weir height of 0.3m (University of South Australia, 1998).

^ Based on the treatable flow rate of the Ecosol RSF 4750 Unit, which is within the Ecosol RSF 4000 product range (Ecosol).

Routing

When determining routing of drainage links it was assumed that all the GPTs were located at the outlets of the sub-catchments. Therefore, no routing was used for the drainage link from the GPT device to its outlet node in MUSIC.

Routing for the drainage link from the GPT source node (as listed in **Table 3.2**) to the GPT remained as for the baseline MUSIC model (i.e. either Muskingum-Cunge routing or no routing).

4 Scenario 2 – 2030 Intensification and Development

4.1 Data Sources

Information regarding Gosford City Council's planned 2030 land use changes and projected growth was obtained from the *Central Coast Regional Strategy* (DoP, 2008) and from consultation with Gosford City Council's Landuse Planning Adviser (Michael Bowman, pers. comm.).

Brownfields Development

Projected land use changes and development within the Brisbane Water Catchment by 2030 will encompass primarily brownfields development, in the form of intensification of residential areas, with little greenfields development. In 2030, no new areas will be rezoned as residential zones, but rather all additional new dwellings will be located within existing residential zones, as part of the process of urban renewal.

The breakdown of additional new residential dwellings, based on information from Council, is as follows:

- Gosford (Regional City) 6,000 additional new dwellings; and
- Woy Woy (Town) 2,200 additional new dwellings.

Approximately 20% intensification by area of residential zones within the Gosford LGA was indicated by Council. To simplify the modelling process it was determined that only intensification of residential zones within the Gosford and Woy Woy areas would be undertaken in the MUSIC model. This is reasonable as the majority of new residential dwellings by 2030 are focused within these areas.

To account for intensifying residential zones in only the Gosford and Woy Woy areas in the MUSIC model, 25% intensification was modelled.

Greenfields Development

The only greenfields development indicated by Council for inclusion in the 2030 Scenario is the proposed industrial development at Somersby, indicated in **Figure 3**. Of Precincts 1 to 5 of the industrial area only part of Precinct 5 (20 ha in area) is included within the MUSIC model catchment boundary.

To represent the rezoning and development of this area (within the MUSIC model catchment boundary), three sub-catchments were resized or rezoned to represent the land use changes, as indicated in **Table 4.1**. The new Somersby1 sub-catchment (formerly Fagan6) represents the proposed industrial development and the resized Fagans3 and Fagans4 sub-catchments are indicated on **Figure 4**.

Table 4.1: 2030 Greenfields Development for Scenario 2

2009				2030 (Scenario 2)			
Sub-Catchment	Area (ha)	Zoning	Impervious Area (%)	Sub-Catchment	Area (ha)	Zoning	Impervious Area (%)
Fagans3	200	Forest	5	Fagans3	197	Forest	5
Fagans4	44	Rural	5	Fagans4	35	Rural	5
Fagans6	9	Quarry	70	Somersby1	20	Industrial	80
TOTAL	**253**				**252**		

4.2 Stormwater Treatment Requirements

Rainwater Tanks

To comply with the BASIX water target requirements for the Gosford LGA (40% reduction in potable water supply compared to a similar dwelling), all 2030 additional new dwellings have been assumed to have a rainwater tank on site. This will facilitate the sustainable reuse of rainwater on site to meet the potable water demand reduction.

According to Sydney Water (2007), a rainwater tank size of 2,000L for each dwelling, assuming an average of three people per household, is sufficient for using rainwater for some household uses such as toilet flushing and watering a small garden area.

An estimated weekly rainwater requirement for an average three person household was calculated according to the information reported in Sydney Water (2007) (**Table 4.2**).

Table 4.2: Estimated* Weekly Rainwater Requirement (After: Sydney Water, 2007)

Activity	Water	Frequency	=
Toilet flush (4-star rated dual flush)	12 litres per person a day	No. of people = **3** x 12 litres x 7 days	**252L**
Garden watering	1,000 litres an hour	No. of hours per week = **0.5** x 1,000 litres	**500L**
Estimated weekly rainwater requirement		TOTAL	**752L**
Estimated daily rainwater requirement		TOTAL	**107L**

* Bold text indicates inputs and calculations made.

The projected numbers of additional dwellings for Gosford and Woy Woy for 2030 are 6,000 and 2,200, respectively, as discussed earlier. The numbers of dwellings for Gosford and Woy Woy were divided up between the sub-catchments based on proportion area in hectares. This method assumes a constant density of additional dwellings in 2030 in the Gosford and Woy Woy sub-catchments marked for 2030 intensification, respectively.

Generic Stormwater Treatment Devices

To comply with Gosford City Council's stormwater treatment requirements for urban development's contained in the *Water Cycle Management Guidelines* (GCC, 2007) all intensified residential areas, and the Somersby industrial area, will be treated by stormwater treatment devices in order to reduce pollutant loads in stormwater from these developments. Council's stormwater treatment requirements for developments, as a percentage retention of the annual average load of stormwater discharge from the developed conditions, are given in **Table 4.3**.

Table 4.3: Gosford City Council Stormwater Treatment Requirements (After: GCC, 2007)

Pollutant	Stormwater Treatment Requirements
Total Suspended Solids (TSS)	80% (Narara Creek Catchment) 70% (Brisbane Water Catchment)
Total Phosphorus (TP)	45% (Narara Creek Catchment) 30% (Brisbane Water Catchment)
Total Nitrogen (TN)	45% (Narara Creek Catchment) 30% (Brisbane Water Catchment)

All intensified residential zones within the Woy Woy area are located within the Brisbane Water Catchment; hence require TSS, TP and TN reduction by 70%, 30% and 30% respectively (**Table 4.3**). All intensified residential zones within the Gosford area, except sub-catchment Gosford3 in the Brisbane Water Catchment, are located within the Narara Creek Catchment; hence require TSS, TP and TN reduction by 80%, 45% and 45% respectively (**Table 4.3**).

A portion of the proposed industrial development at Somersby (sub-catchment Somersby1) is located within the Narara Creek Catchment; hence require the Narara Creek Catchment stormwater treatment requirements as per **Table 4.3**.

4.3 Intensified Residential Zones

To incorporate the 2030 intensified conditions into MUSIC 16 residential sub-catchments were nominated. These 16 sub-catchments, eight in each of the Gosford and Woy Woy areas as shown in **Figure 4,** are listed in **Table 4.4**. **Table 4.4** also indicates the 2009 and subsequent sub-catchment areas as input into MUSIC. The original residential area (indicated with A), is 75% of the 2009 area and the intensified residential area (indicated with B and BT; discussed further in subsequent discussions), is 25% of the 2009 area i.e. 25% intensification by area.

The percentage of impervious area for the original (A) residential areas was not changed in the MUSIC model. Gosford City Council's *Water Cycle Management Guidelines* (2007) indicate that higher density residential development requires a minimum pervious area of 10% of the site. Therefore, the percentage of impervious area for the intensified (B and BT) residential areas was set to 90% in the MUSIC model, as indicated in **Table 4.4**.

Figure 4 also indicates which major tributaries each of the 2030 modified areas drain to. Two of the intensified residential zones in Gosford drain to the Upper Narara Creek tributary, five drain to the Lower Narara Creek tributary and one drains directly to Brisbane Water. One of the intensified residential zones in Woy Woy drains to Ettalong Creek and seven drain directly to Brisbane Water. The proposed industrial development at Somersby drains to Coorumbine Creek.

Table 4.4: MUSIC Residential Sub-catchments Modified for 2030 Intensification

2009 Sub-Catchment	2009 Sub-Catchment Area (ha)	2030 Sub-Catchment	2030 Sub-Catchment Area (ha)	2030 Impervious Area (%)
GOSFORD AREA				
Brady2	116	Brady2A	87	40
		Brady2B	16	90
		Brady2BT	13	90
Fountain1	83	Fountain1A	62	30
		Fountain1B	11	90
		Fountain1BT	9	90
Fountain2	31	Fountain2A	23	30
		Fountain2B	4	90
		Fountain2BT	3	90
Gosford3	46	Gosford3A	34	40
		Gosford3B	6	90
		Gosford3BT	5	90
W_Gosford10	31	W_Gosford10A	23	40
		W_Gosford10B	4	90
		W_Gosford10BT	3	90
W_Gosford9	26	W_Gosford9A	20	40
		W_Gosford9B	4	90
		W_Gosford9BT	3	90
Wingello1	165	Wingello1A	124	40
		Wingello1B	23	90
		Wingello1BT	18	90
Wyoming1	173	Wyoming1A	130	40
		Wyoming1B	24	90
		Wyoming1BT	19	90
WOY WOY AREA				
Woy_P1	257	Woy_P1A	193	40
		Woy_P1B	36	90
		Woy_P1BT	29	90
Woy_P10	104	Woy_P10A	78	50
		Woy_P10B	14	90
		Woy_P10BT	12	90
Woy_P11	180	Woy_P11A	135	50
		Woy_P11B	25	90
		Woy_P11BT	20	90
Woy_P12	180	Woy_P12A	135	50
		Woy_P12B	25	90
		Woy_P12BT	20	90
Woy_P6	66	Woy_P6A	50	50
		Woy_P6B	9	90
		Woy_P6BT	7	90
Woy_P7	94	Woy_P7A	71	50
		Woy_P7B	13	90
		Woy_P7BT	10	90
Woy_P8	116	Woy_P8A	87	50
		Woy_P8B	16	90
		Woy_P8BT	13	90
Woy_P4	88	Woy_P4A	66	50
		Woy_P4B	12	90
		Woy_P4BT	10	90

Roof Area Determination

The intensified residential area was divided into two components (B and BT; where T stands for Tank, in **Table 4.4**), to determine the proportion of the intensified catchment that drains to a rainwater tank (i.e. roof areas only).

An analysis was carried out using recent aerial photography and cadastral data on a sample section of the existing residential zone in sub-catchment Gosford3, to determine the existing roof area percentage and total impervious percentage of the sample section. A roof area of 35% and a total impervious area of 70% were determined for the existing residential density. The percentage impervious of new residential dwellings for 2030 has been assumed to be 90%; hence the sample section results were scaled accordingly to determine the percentage of roof area for the intensified development condition in 2030. This calculation assumes the sample section analysed in sub-catchment Gosford3 is representative of the Gosford and Woy Woy areas. The scaled results indicate a proportion of roof area of 45%.

Therefore the sub-catchment areas in **Table 4.4** suffixed by BT, indicating the roof area draining to rainwater tanks, were calculated as 45% of the total intensified residential area. The areas suffixed by B were therefore assigned to be 55% of the total intensified residential area.

4.4 MUSIC Inputs

In the MUSIC model 45% of each intensified residential area (the roof area) was treated by a rainwater tank, followed by a generic treatment device, forming a treatment train. The remaining 55% of each intensified residential area was only treated by the generic treatment device.

The treatment efficiencies of the generic treatment devices were set to match Council's stormwater treatment requirements (**Table 4.3**), as opposed to matching performance criteria of existing stormwater treatment devices.

A schematic of the MUSIC model setup, for a sample intensified residential area, is shown in **Figure 5**.

Rainwater Tanks

All rainwater tanks for all intensified sub-catchments in the MUSIC model had the following common properties:

- Low flow by-pass (m^3/s) 0
- High flow by-pass (m^3/s) 100
- Depth above overflow (m) 0.2
- Overflow pipe diameter (mm) 90

Rainwater tank design properties, including the overflow pipe diameter (90mm) and the tank surface area ($1.4m^2$), were sourced from a typical product that might be used (i.e. the Nylex *Rainwater Tanks* (2008) brochure) for a 2kL tank.

Table 4.5 details the MUSIC inputs for rainwater tanks, specific to each intensified residential sub-catchment.

Table 4.5: MUSIC Inputs for Scenario 2 Rainwater Tanks

2030 Sub-Catchment	Number of 2kL Rain Tanks (i.e. Assumed Number of Dwellings)*	Storage Properties		Re-Use Properties
		Total Volume Below Overflow Pipe (kL)	Total Surface Area (m^2)	Total Daily Demand (kL/day)
GOSFORD AREA				
Brady2(B + BT)	1042	2084	1459	112
Fountain1(B + BT)	743	1485	1040	79
Fountain2(B + BT)	273	547	383	29
Gosford3(B + BT)	408	816	571	44
W_Gosford10(B + BT)	275	550	385	29
W_Gosford9(B + BT)	233	467	327	25
Wingello1(B + BT)	1479	2958	2071	158
Wyoming1(B + BT)	1547	3093	2165	165
Total	**6000**	**12000**	**8400**	**642**
WOY WOY AREA				
Woy_P1(B + BT)	521	1042	730	56
Woy_P10(B + BT)	211	421	295	23
Woy_P11(B + BT)	365	730	511	39
Woy_P12(B + BT)	365	730	511	39
Woy_P6(B + BT)	134	269	188	14
Woy_P7(B + BT)	191	381	267	20
Woy_P8(B + BT)	236	471	330	25
Woy_P4(B + BT)	178	355	249	19
Total	**2200**	**4400**	**3080**	**235**

* This approach conservatively assumes that one dwelling consists of only one house in the intensification Scenario i.e. no multi-storey units or duplex style dwellings have been incorporated, which would increase daily demand levels.

Generic Stormwater Treatment Devices

All generic stormwater treatment devices for intensified sub-catchments in the Narara Creek catchment had the following common aggregated input properties in the MUSIC model, in accordance with Council's requirements (**Table 4.3**):

- Low flow by-pass (m^3/s) 0
- High flow by-pass (m^3/s) 100
- Transfer functions
  - TSS 80% reduction
  - TP 45% reduction
  - TN 45% reduction

Similarly, all generic stormwater treatment devices for intensified sub-catchments in the Brisbane Water catchment had the following common aggregated input properties in the MUSIC model, (**Table 4.3**):

- Low flow by-pass (m^3/s) 0
- High flow by-pass (m^3/s) 100

- Transfer functions
  - TSS 70% reduction
  - TP 30% reduction
  - TN 30% reduction

Only a generic treatment device (as opposed to the inclusion of a rainwater tank), with MUSIC inputs based on the Narara Creek Catchment requirements (**Table 4.3**), was used to treat stormwater discharge from the proposed greenfields industrial development at Somersby1.

5 Scenario 3 – 2030 Development with DECC Targets

5.1 Data Sources

Scenario 3 updated the Scenario 2 MUSIC model by replacing Council's stormwater treatment requirements, for the generic stormwater treatment devices, with the proposed DECC stormwater targets.

The proposed DECC stormwater targets were obtained from *Managing Urban Stormwater: Environmental Targets* (DECC and SMCMA, 2007).

DECC Stormwater Targets

The DECC stormwater targets, as a percentage reduction in the average annual loads, are given in **Table 5.1**.

Table 5.1: DECC Stormwater Targets (After: DECC and SMCMA, 2007)

Pollutant	Stormwater Treatment Requirements
TSS	85%
TP	65%
TN	45%

5.2 MUSIC Inputs

Updated Generic Stormwater Treatment Devices

All generic stormwater treatment devices for the 16 intensified residential sub-catchments (**Table 4.4**) and the greenfields Somersby industrial development, incorporated in Scenario 2, were updated to the following common aggregated input properties in the Scenario 3 MUSIC model, in accordance with DECCs requirements (**Table 5.1**):

- Low flow by-pass (m^3/s) 0
- High flow by-pass (m^3/s) 100
- Transfer functions
  - TSS 85% reduction
  - TP 65% reduction
  - TN 45% reduction

6 Scenario 4 – Regional Treatment Devices

6.1 Data Sources

Scenario 4 modelled the full suite of management options for the Estuary suggested by Council or the community, where applicable, which addressed the management goal of Water and Sediment Quality. Eight management options, as listed in **Table 6.1**, were assessed for incorporation into the MUSIC model. Scenario 4 updated the Scenario 3 MUSIC model, assuming that Council adopts the DECC (2007) stormwater targets for future developments described in Scenario 3 by 2030.

Table 6.1: Management Options (Addressing Water and Sediment Quality Management Goals) Modelled in MUSIC for Scenario 4

EMS Option ID	Strategy Outline	Location
P05	Investigate the need for sediment traps and other stormwater management measures to control any erosion and sedimentation from sloping lands draining to the stormwater outlet opposite Byalla Lane.	Saratoga
W10	Remediate (or pipe) open drains and install sediment traps for those drains running from Wilkie King Ave and Mundoora Ave, Yattalunga.	Yattalunga
W04	Provide additional sediment traps for locations draining to Correa Bay. Sediment traps should target catchment inflows from the Bulls Hill Quarry and Garbage tip.	Correa Bay
W13	Develop and implement measures to address stormwater quality issues associated with runoff from fire trails on Blackwall Mountain.	Blackwall
W06	Install and maintain as required sediment traps targeting stormwater flows draining from the escarpment at Hardy's Bay.	Hardy's Bay
W17	Implement a program of maintenance to address the accumulation of litter in the open drain near Beach Street. Long term management of this issue should also be considered, for example, public education and/or the implementation of additional gross pollutant traps.	Ettalong
W14*	Develop and implement measures to address stormwater quality issues associated with runoff from the access road and fire trails near Fisherman's Parade.	Daley's Point
W01	Investigate options for implementing catchment-based WSUD features in the catchment in order to manage stormwater quality and quantity, with a priority focus on the Narara and Erina Creek catchments, followed by Kincumber Creek catchment.	Catchment-wide

* This option was not modelled in MUSIC.

Only one management option from **Table 6.1** was not modelled in MUSIC; W14. Based on the assessment of pits, pipes and topographic data this option was determined as not feasible as there is a lack of pits/pipes infrastructure in this area to incorporate an end of pipe GPT device and the area is too steep to facilitate WSUD features such as bioretention systems (which are generally most effective on flatter slopes). Further investigations are required at this site to identify suitable treatment options.

6.2 Regional Treatment Devices

The full suite of regional treatment devices, as indicated in **Table 6.2**, was incorporated into the MUSIC model for Scenario 4. Each 'Treatment Train' in **Table 6.2** involves the following devices in series: GPT (assumed to be a CDS Unit), Bioretention System and Rainwater Tank for irrigation purposes.

Table 6.2: Regional Treatment Devices Incorporated into Scenario 4

EMS Option ID	Adjusted MUSIC Sub-Catchment (i.e. Drains These Catchments)	WSUD Feature(s) Incorporated	Device Name in MUSIC	Major Tributary (i.e. Drains to These Tributaries)
P05	Saratoga1	GPT (CDS Unit)	Byalla Ln CDS	Direct to Brisbane Water
W10(1)	Saratoga1, Saratoga2	GPT (CDS Unit)	Wilkie King Ave CDS	Direct to Brisbane Water
W10(2)	Egan3	GPT (CDS Unit)	Mundoora Ave CDS	Direct to Brisbane Water
W04	W_Inlet9	Bioretention System	Bulls Hill Quarry Bioretention	Woy Woy Creek
W13	Woy_P9	GPT (CDS Unit)	Blackwall Mountain CDS	Direct to Brisbane Water
W06	Hardy4	GPT (CDS Unit)	Hardy's Bay CDS	Direct to Brisbane Water
W17	Woy_P11A	GPT (CDS Unit)	Ettalong Beach/Beach St CDS	Direct to Brisbane Water
W01	W_Gosford1	Treatment Train (1)*	Treatment Train 1	Direct to Brisbane Water
	Kincumber3, Kincumber25	Treatment Train (2)*	Treatment Train 2	Kincumber Creek
	Nunn2, Nunn3	Treatment Train (3)*	Treatment Train 3	Lower Erina Creek
	Hylton_Pk1, Hylton_Pk2, Hylton_Pk3	Treatment Train (4)*	Treatment Train 4	Lower Erina Creek
	W_Gosford3, W_Gosford4, W_Gosford5	Treatment Train (5)*	Treatment Train 5	Lower Narara Creek
	Wyoming1A	Treatment Train (6)*	Treatment Train 6	Lower Narara Creek
	Narara1, W_Gosford10A	Treatment Train (7)*	Treatment Train 7	Lower Narara Creek
	Fountain1A, Fountain3	Treatment Train (8)*	Treatment Train 8	Upper Narara Creek
	Caroline1, Caroline2, Caroline3	Treatment Train (9)*	Treatment Train 9	Direct to Brisbane Water

* Each Treatment Train involves the following devices in series: GPT (assumed to be a CDS Unit), Bioretention System and Rainwater Tank for irrigation purposes. Details and sizes of the features are described in the following sections.

The general locations of each of these regional treatment devices and the treatment trains within the Brisbane Water Catchment are indicated on **Figure 6**.

Table 6.2 also indicates which major tributaries each of these regional treatment devices drain to. Eight devices drain directly to Brisbane Water, while four drain to Narara Creek and two drain to Erina Creek. One device (W04) drains to Woy Woy Creek, which feeds into Correa Bay, and one Treatment Train drains to Kincumber Creek.

The locations of each of these regional treatment devices were determined based on desktop assessments, using GIS layers of pits, pipes, 2m contours, waterways (such as creeks and major tributaries) and recent aerial photography. It should be noted that these locations are approximate and no site-specific assessments have been undertaken to evaluate the engineering feasibility or practical implications of these devices in these areas i.e. available space for a CDS unit of a specific size. The treatment devices assessed in this scenario cannot be directly implemented to improve sediment and water quality in the catchment without further assessment. Prior to implementation of any of the devices incorporated in this scenario, a detailed social, environmental and economic assessment on a localised scale would need to be undertaken and site-specific practicalities such as site access to the devices for maintenance would need to be considered.

Gross Pollutant Traps

CDS Units were selected to treat the management options which identified sedimentation issues. Each of the CDS Units incorporated into Scenario 4 had the same treatment capacities as the CDS Units incorporated into Scenario 2 and provided in **Table 6.3**. CDS Units are generally more effective in retaining suspended solids and particulate matter than treating TP and TN, as indicated in **Table 6.3**.

Table 6.3: MUSIC Input Parameters for CDS Unit Treatment Efficiencies for Scenario 4

Parameter	CDS Unit
Low Flow By-pass (m^3/s)	0*
High Flow By-pass (m^3/s)	0.4*
TSS Reduction	70% (between 75 and 700mg/L)
TP Reduction	30% (between 0.5 and 4.5mg/L)
TN Reduction	0%
Performance Data Source(s)	Rocla and CRC for Catchment Hydrology, 2005

* These values have been assumed.

The catchment areas draining to the CDS Units identified in **Table 6.2** are contained in **Table 6.4**. The source nodes in MUSIC were adjusted as necessary to represent these treated catchment areas, which are also indicated on **Figure 7**.

Table 6.4: CDS Unit and Bioretention System Treatment Areas for Scenario 4

EMS Option ID	Treatment Device	Device Treatment Area (ha)	MUSIC Sub-Catchments Drained	Device Treatment Area From Each Sub-Catchment (ha)
P05	CDS Unit	8	Saratoga1(2)	8
W10(1)	CDS Unit	24	Saratoga1(3)	10
	CDS Unit		Saratoga2	14
W10(2)	CDS Unit	2	Egan3(2)	2
W04	Bioretention System	37	W_Inlet9	37
W13	CDS Unit	5	Woy_P9(2)	5
W06	CDS Unit	5	Hardy4(2)	5
W17	CDS Unit	61	Woy_P11A(2)	61

Bioretention Systems

A Bioretention System was selected to treat the stormwater from the Bulls Hill Quarry, to also target TP and TN as well as reduce the sediment pollutant loads from the site. The treatment area for the Bioretention System is indicated in **Table 6.4** and **Figure 7**, and encompasses the entire Bulls Hill Quarry site. No suitable location for a similar Bioretention System could be found for the Garbage tip site based on the information available (as noted in **Table 6.1**; also referred to as the Woy Woy Waste Disposal Depot), hence this aspect of Management Option W04 was not modelled.

Treatment Trains

To address the catchment-wide Management Option W01, the following approach was used:

- Recent aerial photography was inspected to locate playing fields and reserves within the study area where irrigation is likely required, and then these areas were mapped as 'Tank Irrigation Areas';
- Available GIS layers were inspected to roughly determine suitable locations for Bioretention Systems, proximal to these areas requiring irrigation; and
- The priority focus for these treatment trains was in the Narara and Erina Creek catchments, followed by the Kincumber Creek catchment, to reduce pollutant loading within these Creeks.

Each Treatment Train incorporates a GPT (CDS Unit) for initial treatment, followed by a Bioretention System for further, extended treatment of pollutants, followed by a rainwater tank to collect stormwater for irrigation of the indicated playing fields and reserves (**Figure 7**). The general setup of this Treatment Train in MUSIC can be seen in **Figure 8**.

The catchment areas draining to the 'Treatment Trains' identified in **Table 6.2** are contained in **Table 6.5**. The source nodes in MUSIC were adjusted as necessary to represent these catchment areas, which are also indicated on **Figure 7**.

Table 6.5: Treatment Train Catchment Areas for Scenario 4

EMS Option ID	Treatment Device	Nominated Playing Field / Reserve for Rainwater Tank Irrigation	Device Catchment Area (ha)	MUSIC Sub-Catchments Drained*	Device Catchment Area From Each Sub-Catchment (ha)
W01	Treatment Train 1	Garnet Adcock Memorial Park	26	W_Gosford1	26
	Treatment Train 2	Frost Reserve	28	Kincumber3(2)	4
				Kincumber25(2)	24
	Treatment Train 3	Erina Oval	32	Nunn2(2)	4
				Nunn3(2)	28
	Treatment Train 4	Hylton Moore Park	161	Hylton_Pk1(2)	20
				Hylton_Pk2	106
				Hylton_Pk3	35
	Treatment Train 5	Victoria Park (Gosford Golf Course)	82	W_Gosford3(2)	26
				W_Gosford4	17
				W_Gosford5(2)	39
	Treatment Train 6	Alan Davidson Park	8	Wyoming1A(2)	8
	Treatment Train 7	Gavenlock Oval	10	Narara1(2)	3
				W_Gosford10A(2)	7
	Treatment Train 8	Narara Valley High School Playing Fields	46	Fountain1A(2)	39
				Fountain3(2)	7
	Treatment Train 9	St Edwards Christian Brothers School Playing Fields	58	Caroline1(2)	5
				Caroline2(2)	35
				Caroline3(2)	18

* If the MUSIC Sub-Catchment name is suffixed by (2), this indicates that the original MUSIC node was split, as indicated in **Figure 8**, so that part of the catchment flow could be routed through the relevant treatment device.

The GPT (CDS Unit) component of each Treatment Train was set to the same treatment efficiencies as per **Table 6.3**. Specific inputs into MUSIC are detailed in **Section 6.3**.

The Bioretention System component followed the GPT in each Treatment Train. These treatment devices were approximately sized based on available space through inspection of recent aerial photography. Specific inputs into MUSIC are detailed in **Section 6.3**.

Lastly, the Rainwater Tank component followed the Bioretention System in each Treatment Train. These rainwater tanks were all set to a standard large size of 350kL, as these was considered to be the largest tank size feasible at the majority of the sizes. The purpose of these tanks is to collect stormwater, via the pits and pipe system, from the entire treatment area, for irrigation use on the nominated playing fields and reserves (listed in **Table 6.5**). In order to calculate the daily demand irrigation requirements for each playing field/reserve, the areal potential evapotranspiration data input into the MUSIC model was used to determine how demand might vary monthly over the course of an average rainfall year. The evapotranspiration data (mm) was also used to determine how much moisture would be lost from the area of each playing field/reserve (m^2), and hence what volume of water (m^3) would be required to replace this, assuming no rainfall occurs.

The monthly areal potential evapotranspiration data used, taken from the *Climate Atlas of Australia* (BoM, 2003) and results of this analysis are contained in **Table 6.6**.

Table 6.6: Monthly Areal Potential Evapotranspiration

Month	Monthly Areal Potential Evapotranspiration (mm)	Percentage of Annual (%)
January	179	14
February	142	11
March	139	11
April	91	7
May	57	4
June	44	3
July	47	4
August	62	5
September	89	7
October	130	10
November	153	12
December	164	13
Annual	**1297**	**100**

Specific inputs into MUSIC for each Rainwater Tank are detailed in **Section 6.3**.

6.3 MUSIC Inputs

Gross Pollutant Traps

All GPTs (CDS Units) incorporated in Scenario 4 had the following common aggregated input properties in the MUSIC model, based on product information (Rocla) and the MUSIC Manual (CRC for Catchment Hydrology, 2005):

- Low flow by-pass (m^3/s) 0
- High flow by-pass (m^3/s) 0.4
- Transfer functions
  - TSS 70% reduction (between 75 and 700mg/L)
  - TP 30% reduction (between 0.5 and 4.5mg/L)
  - TN 0% reduction

Bioretention Systems

All Bioretention Systems incorporated in Scenario 4 had the following common aggregated input properties in the MUSIC model. These properties were assumed based on standard practice.

- Low flow by-pass (m^3/s) 0
- High flow by-pass (m^3/s) 100
- Extended detention depth (m) 0.15
- Seepage loss (mm/hr) 0
- Filter depth (m) 0.6
- Filter median particle diameter (mm) 5
- Saturated hydraulic conductivity (mm/hr) 100
- Depth below underdrain pipe (% of Filter depth) 17
- Overflow weir width (m) 5

It was assumed that the Bioretention Systems would be lined to prevent infiltration to groundwater; hence seepage loss was assumed to be 0mm/hr.

Table 6.7 provides the specific Bioretention System input properties that were calculated for each Bioretention System for the MUSIC model.

Table 6.7: Bioretention System Inputs into MUSIC

Device Name	Approximate Surface Area (m^2)	Approximate Filter Area (m^2)*
Bulls Hill Quarry Bioretention	12,120	12,120
BioR1 (of WSUD Treatment Train 1)	2,200	2,200
BioR2 (of WSUD Treatment Train 2)	2,820	2,820
BioR3 (of WSUD Treatment Train 3)	1,900	1,900
BioR4 (of WSUD Treatment Train 4)	8,850	8,850
BioR5 (of WSUD Treatment Train 5)	7,100	7,100
BioR6 (of WSUD Treatment Train 6)	4,450	4,450
BioR7 (of WSUD Treatment Train 7)	1,100	1,100
BioR8 (of WSUD Treatment Train 8)	12,080	12,080
BioR9 (of WSUD Treatment Train 9)	5,000	5,000

* The filter area was set equal to the surface area. In doing this, it is being assumed that the Bioretention System is a box shape, with vertical side slopes, as opposed to a trapezoidal shape with sloping sides. This is reasonable for the purposes of this assessment.

Rainwater Tanks

All Rainwater Tanks incorporated in Scenario 4 had the following common aggregated input properties in the MUSIC model. These properties were assumed based on standard practice.

- Low flow by-pass (m^3/s) 0
- High flow by-pass (m^3/s) 100
- Volume below overflow pipe (kL) 350
- Depth above overflow (m) 0.2
- Surface area (m^2) 120
- Overflow pipe diameter (mm) 225

It was assumed, for practical reasons, that no tanks greater than 350kL would be installed. Assuming a height of approximately 3m for these tanks, a surface area of approximately 120m^2 was assumed. Elements of the concept design of these tanks (i.e. whether they would be located above or below ground) have not been considered in this assessment and would need to be investigated further on a site-specific and localised scale.

Table 6.8 provides the specific Rainwater Tank input properties that were calculated for each Rainwater Tank for the MUSIC model, based on irrigation requirements, as explained in **Section 6.2**.

Table 6.8: Rainwater Tank Inputs into MUSIC

Device Name	Approximate Annual Demand (kL/year)*
Tank1 (of WSUD Treatment Train 1)	140,600
Tank2 (of WSUD Treatment Train 2)	55,100
Tank3 (of WSUD Treatment Train 3)	27,000
Tank4 (of WSUD Treatment Train 4)	11,500
Tank5 (of WSUD Treatment Train 5)	539,000
Tank6 (of WSUD Treatment Train 6)	46,100
Tank7 (of WSUD Treatment Train 7)	22,600
Tank8 (of WSUD Treatment Train 8)	85,700
Tank9 (of WSUD Treatment Train 9)	50,500

* The total kL per year reported here, as Annual Demand, is distributed according to the distribution given in **Table 6.6**.

7 Scenario 5 – Selected Regional Treatment Devices

7.1 Data Sources

Scenario 5 updated the Scenario 4 MUSIC model and provides Council with the top five most effective regional treatment devices, based on the management options presented in the Brisbane Water EMS. It is considered that these five most effective regional treatment devices various target 'hotspot' areas and major tributaries within the Brisbane Water catchment and can feasibly be implemented by Council in the next five to ten years.

7.2 Selected Regional Treatment Devices

A comparison was made between the 16 modelled regional treatment devices from Scenario 4, assessing how effective each device was in removing pollutant loads from Brisbane Water. The 16 devices were ranked to determine the top five, according to which captured and removed the most pollutants from the system. Only the key pollutants TSS, TP and TN (key aquatic ecosystem stressors) were considered. The results of the ranking are shown in **Table 7.1**.

Table 7.1: Ranking of Scenario 4 Regional Treatment Devices by Effectiveness

EMS Option ID	Annual Load Removed by Device (kg/yr)			Sum of Load Removed (kg/yr)	Ranking^
	TSS	TP	TN		
P05	1,862	0	0	1,862	-
W10(1)	1,757	0	0	1,757	-
W10(2)	470	0	0	470	-
W04	69,647	39	246	69,932	1
W13	0	0	0	0	-
W06	814	0	0	814	-
W17	10,486	0	0	10,486	-
W01(TT1)	3,853	7	59	3,920	-
W01(TT2)	15,367	34	184	15,585*	5*
W01(TT3)	16,212	33	169	16,414	-
W01(TT4)	62,250	125	599	62,975	2
W01(TT5)	1,062	9	102	1,173	-
W01(TT6)	5,510	13	81	5,605	-
W01(TT7)	4,907	11	60	4,977	-
W01(TT8)	20,787	45	237	21,068	4
W01(TT9)	22,468	47	249	22,763	3

^ The ranking is colour coded as follows: Yellow = 1st, Purple = 2nd, Pink = 3rd, Green = 4th and Blue = 5th.

* Treatment Train 2 (TT2) was selected over Treatment Train 3 (TT3), even though TT3 had the higher Total Load Captured, because a greater weighting was given to TP and TN here, over TSS. The modelling indicates that TT2 captures and retains both TP and TN more effectively than TT3.

Table 7.2 is the list of the top five selected regional treatment devices, which were incorporated into the Scenario 5 MUSIC model. All device details were as given in Scenario 4 (**Section 4**).

Table 7.2: Selected Regional Treatment Devices Incorporated into Scenario 5

EMS Option ID	WSUD Feature	Major Tributary (i.e. Drains to These Tributaries)
W04	Bulls Hill Quarry Bioretention System	Woy Woy Creek
W01 (TT2)	Treatment Train 2*	Kincumber Creek
W01 (TT4)	Treatment Train 4*	Lower Erina Creek
W01 (TT8)	Treatment Train 8*	Upper Narara Creek
W01 (TT9)	Treatment Train 9*	Direct to Brisbane Water

* Each Treatment Train involves the following devices in series: GPT (assumed to be a CDS Unit), Bioretention System and Rainwater Tank for irrigation purposes.

8 Results

8.1 Scenario 1

The results from Scenario 1, incorporating GPTs into the Brisbane Water MUSIC model, are given in **Table 8.1**.

Table 8.1: Scenario 1 Annual Loads for Representative Average Year (1995) with GPTs

Location	Area (ha)	Annual Flow (ML/yr)	Runoff Coefficient	Annual Loads (kg/yr)			Percentage Change from Baseline Model (%)		
				TSS	TP	TN	TSS	TP	TN
Upper Narara	2,811	8,920	0.26	831,000	1,810	15,000	0.0	0.0	0.0
Lower Narara	4,565	16,800	0.30	1,670,000	3,810	30,500	-0.6	-0.3	-0.3
Upper Erina	1,926	4,380	0.18	245,000	541	5,420	-0.4	0.0	0.0
Lower Erina	3,252	9,310	0.23	771,000	1,860	15,500	-0.4	0.0	0.0
Kincumber Creek	484	2,050	0.34	225,000	599	4,500	-5.5	-0.8	-0.9
Woy Woy Creek	588	1,760	0.24	167,000	260	2,470	0.0	0.0	0.0
Ettalong Creek	780	3,350	0.35	346,000	979	7,080	-0.6	-0.2	0.0
Coorumbine Creek	361	1,450	0.33	160,000	329	2,710	0.0	0.0	0.0
Direct to Brisbane Water	1,699	10,480	0.50	1,185,000	3,812*	25,820*	-2.5	0.4*	0.5*
Total Catchment	**16,466**	**58,500**	**0.29**	**5,600,000**	**14,000**	**109,000**	**-1.1**	**0.0**	**0.0**

* The calculated increase in TP and TN; 0.4% and 0.5% respectively, is likely erroneous due to the rounding of MUSIC outputs from the baseline model (see **Table 2.1** for discussion) and can reasonably be assumed to be 0% and 0% respectively i.e. no change in the loads of TP and TN for Scenario 1.

8.2 Scenario 2

The results from Scenario 2, with 25% intensification of Gosford and Woy Woy residential areas (brownfields development) and the proposed Somersby industrial development (greenfields development) in the 2030 Brisbane Water MUSIC model are given in **Table 8.2**. These, and subsequent results, have been compared with the Scenario 1 results, as Scenario 1 represents a less conservative and more realistic assessment of pollutant loads than the baseline condition.

Table 8.2: Scenario 2 Annual Loads for Representative Average Year (1995) with 25% Intensification and Greenfields Development for 2030

Location	Area (ha)	Annual Flow (ML/yr)	Runoff Coefficient	Annual Loads (kg/yr)			Percentage Change from Scenario 1 (%)		
				TSS	TP	TN	TSS	TP	TN
Upper Narara	2,811	9,020	0.26	820,000	1,810	15,000	-1.3	0.0	0.0
Lower Narara	4,565	17,300	0.31	1,590,000	3,780	30,400	-4.8	-0.8	-0.3
Upper Erina	1,926	4,380	0.18	245,000	541	5,420	0.0	0.0	0.0
Lower Erina	3,252	9,310	0.23	771,000	1,860	15,500	0.0	0.0	0.0
Kincumber Creek	484	2,050	0.34	225,000	599	4,500	0.0	0.0	0.0
Woy Woy Creek	588	1,760	0.24	167,000	260	2,470	0.0	0.0	0.0
Ettalong Creek	780	3,500	0.36	326,000	988	7,170	-5.8	0.9	1.3
Coorumbine Creek	361	1,530	0.34	145,000	339	2,760	-9.4	3.0	1.8
Direct to Brisbane Water	1,699	11,250	0.54	1,101,000	3,923	26,780	-9.5	3.4	4.3
Total Catchment	**16,466**	**60,100**	**0.30**	**5,390,000**	**14,100**	**110,000**	**-3.8**	**0.7**	**0.9**

8.3 Scenario 3

The results from Scenario 3, which updated the Scenario 2 MUSIC model to incorporate the DECC stormwater targets (DECC and SMCMA, 2007) in place of Council's current stormwater treatment requirements (GCC, 2007) for the generic stormwater treatment devices, are given in **Table 8.3**.

Table 8.3: Scenario 3 Annual Loads for Representative Average Year (1995), Updating Scenario 2 with DECC Stormwater Targets for Generic Stormwater Treatment Devices

Location	Area (ha)	Annual Flow (ML/yr)	Runoff Coefficient	Annual Loads (kg/yr)			Percentage Change from Scenario 1 (%)		
				TSS	TP	TN	TSS	TP	TN
Upper Narara	2,811	9,020	0.26	819,000	1,790	15,000	-1.4	-1.1	0.0
Lower Narara	4,565	17,300	0.31	1,580,000	3,680	30,400	-5.4	-3.4	-0.3
Upper Erina	1,926	4,380	0.18	245,000	541	5,420	0.0	0.0	0.0
Lower Erina	3,252	9,310	0.23	771,000	1,860	15,500	0.0	0.0	0.0
Kincumber Creek	484	2,050	0.34	225,000	599	4,500	0.0	0.0	0.0
Woy Woy Creek	588	1,760	0.24	167,000	260	2,470	0.0	0.0	0.0
Ettalong Creek	780	3,500	0.36	317,000	929	6,980	-8.4	-5.1	-1.4
Coorumbine Creek	361	1,530	0.34	143,000	328	2,760	-10.6	-0.3	1.8
Direct to Brisbane Water	1,699	11,250	0.54	1,063,000	3,613	24,970	-12.6	-4.8	-2.8
Total Catchment	**16,466**	**60,100**	**0.30**	**5,330,000**	**13,600**	**108,000**	**-4.8**	**-2.9**	**-0.9**

8.4 Scenario 4

The results from Scenario 4, which updated the Scenario 3 MUSIC model to incorporate a suite of regional treatment devices that correlated with management options assessed in the Brisbane Water EMS, are given in **Table 8.4**.

It should be noted that the percentage change from previous results has been calculated in comparison to Scenario 3 results, rather than Scenario 1 results. This provides a better indication of pollutant load reductions achieved by the regional treatment devices.

Table 8.4: Scenario 4 Annual Loads for Representative Average Year (1995), Incorporating a Suite of Regional Treatment Devices

Location	Area (ha)	Annual Flow (ML/yr)	Runoff Coefficient	Annual Loads (kg/yr)			Percentage Change from Scenario 3 (%)		
				TSS	TP	TN	TSS	TP	TN
Upper Narara	2,811	8,990	0.26	798,000	1,750	14,800	-2.6	-2.2	-1.3
Lower Narara	4,565	17,100	0.30	1,520,000	3,550	29,700	-3.8	-3.5	-2.3
Upper Erina	1,926	4,380	0.18	245,000	541	5,420	0.0	0.0	0.0
Lower Erina	3,252	9,280	0.23	693,000	1,700	14,700	-10.1	-8.6	-5.2
Kincumber Creek	484	2,020	0.34	209,000	565	4,310	-7.1	-5.7	-4.2
Woy Woy Creek	588	1,760	0.24	97,300	220	2,230	-41.7	-15.4	-9.7
Ettalong Creek	780	3,500	0.36	317,000	929	6,980	0.0	0.0	0.0
Coorumbine Creek	361	1,530	0.34	143,000	328	2,760	0.0	0.0	0.0
Direct to Brisbane Water	1,699	11240	0.54	1,037,700	3,617	25,100	-2.4	0.1*	0.5*
Total Catchment	**16,466**	**59,800**	**0.29**	**5,060,000**	**13,200**	**106,000**	**-5.1**	**-2.9**	**-1.9**

* The calculated increase in TP and TN by 0.1% and 0.5% respectively from Scenario 3 results is likely erroneous due to the rounding of MUSIC outputs from the baseline model and can reasonably be assumed to be 0% and 0% respectively i.e. no change in the loads of TP and TN from Scenario 3.

8.5 Scenario 5

The results from Scenario 5, which refined the Scenario 4 MUSIC model by selecting only the top five most effective regional treatment devices, are given in **Table 8.5**.

It should be noted that the percentage change from previous results has been calculated in comparison to Scenario 3 results, rather than Scenario 1 results. This provides a better indication of pollutant load reductions achieved by the regional treatment devices.

Table 8.5: Scenario 5 Annual Loads for Representative Average Year (1995), Incorporating the Selected Regional Treatment Devices

Location	Area (ha)	Annual Flow (ML/yr)	Runoff Coefficient	Annual Loads (kg/yr)			Percentage Change from Scenario 3 (%)		
				TSS	TP	TN	TSS	TP	TN
Upper Narara	2,811	8,990	0.26	798,000	1,750	14,800	-2.6	-2.2	-1.3
Lower Narara	4,565	17,300	0.31	1,560,000	3,630	30,200	-1.3	-1.4	-0.7
Upper Erina	1,926	4,380	0.18	245,000	541	5,420	0.0	0.0	0.0
Lower Erina	3,252	9,300	0.23	709,000	1,740	14,900	-8.0	-6.5	-3.9
Kincumber Creek	484	2,020	0.34	209,000	565	4,310	-7.1	-5.7	-4.2
Woy Woy Creek	588	1,760	0.24	97,300	220	2,230	-41.7	-15.4	-9.7
Ettalong Creek	780	3,500	0.36	317,000	929	6,980	0.0	0.0	0.0
Coorumbine Creek	361	1,530	0.34	143,000	328	2,760	0.0	0.0	0.0
Direct to Brisbane Water	1,699	11220	0.54	1,051,700	3,597	25,400	-1.1	-0.4	1.7*
Total Catchment	**16,466**	**60,000**	**0.30**	**5,130,000**	**13,300**	**107,000**	**-3.8**	**-2.2**	**-0.9**

* The calculated increase in TN by 1.7% from Scenario 3 results is likely erroneous due to the rounding of MUSIC outputs from the baseline model and can reasonably be assumed to be 0% i.e. no change in the loads of TN from Scenario 3.

9 Discussion and Outcomes

The annual loads presented in **Section 8** indicate pollutant loads from the main tributaries within the model and the smaller sub-catchments which drain directly to Brisbane Water.

9.1 Scenario 1

Scenario 1 indicated no substantial changes to pollutant loads from the baseline conditions due to the 11 modelled GPTs. An overall reduction in TSS delivered to Brisbane Water by 1.1% was noted, with no overall change to the loads of TP and TN delivered.

Scenario 1 showed that the Narara Creek catchment still represents the largest contributor of pollutant loads to Brisbane Water with existing GPTs; being approximately 42% of the total load. The Erina Creek catchment still produces approximately 18% of the pollutant load, while the smaller major tributaries still contribute a total of approximately 16%.

The sub-catchments that drain directly to the Brisbane Water Estuary, such as highly developed foreshore catchments, still represent approximately 24% of the total pollutant load that enters Brisbane Water.

The Kincumber Creek and Ettalong Creek catchments and the sub-catchments that drain directly to Brisbane Water still produce the greatest pollutant loads per hectare, compared to the other major tributaries of Brisbane Water.

9.2 Scenario 2

Scenario 2 indicated that intensified residential development by 2030 will not have a substantial impact on the overall pollutant loads delivered to Brisbane Water from the catchment if stormwater treatment devices, including rainwater tanks, are implemented in accordance with Gosford City Council's Stormwater Guidelines (2007). An overall reduction in TSS and minor overall increases (less than 1%) of TP and TN delivered to Brisbane Water is noted due to new development with associated treatment (**Table 8.2**).

Changes to pollutant loads from Coorumbine Creek for Scenario 2 are solely due to the land use change for the proposed portion of the Somersby industrial development. There was an increase in loads of TP and TN (3% and 1.8%, respectively) from this major tributary (**Table 8.2**). This can in part be explained by the absence of the use of rainwater tank treatment within the treatment train at this site (the demand is potentially low but dependent on the type of industry that could be expected), but is also due to the high impervious areas and pollutant loads associated with industrial sites. These results indicate that, even with the application of Council's current stormwater targets for the Narara Creek Catchment, a slight overall increase in TP and TN pollutant loads from this tributary will be delivered to Brisbane Water.

An increase in loads of TP and TN (3.4% and 4.3%, respectively) was also noted for sub-catchments that drain directly to Brisbane Water (**Table 8.2**). There are two factors driving this increase. Firstly, the increase in impervious areas (to 90%) for these intensified catchments will lead to increased runoff and hence increased pollutant loads. Secondly, all intensified sub-catchments that drain directly to Brisbane Water are located within the

Brisbane Water Catchment and therefore Council's less stringent stormwater requirements (see **Table 4.3**) were applied to generic treatment devices for these areas. These results indicate that, even with the application of Council's current stormwater targets for the Brisbane Water Catchment, a slight overall increase in TP and TN pollutants loads from these direct sub-catchments will be delivered to Brisbane Water.

9.3 Scenario 3

If Council were to adopt DECC's targets for stormwater treatment requirements for future developments, Scenario 3 indicates that an overall and more substantial reduction in pollutants in Brisbane Water would be achieved compared with Scenario 2 (**Table 8.2**).

Notably Scenario 3 results in a decrease in TSS and TP pollutants loads delivered from Coorumbine Creek due to part of the proposed Somersby industrial development, but not a decrease in TN. This indicates that DECC's targets are effective in reducing pollutant loads for TP from the proposed Somersby industrial site (**Table 8.3**), where Council's current targets were less so. However, more stringent targets for the site are required to reduce TN loads in Coorumbine Creek to maintain the loads at existing levels (i.e. no change).

Scenario 3 also results in a decrease in all pollutants delivered from sub-catchments draining directly to Brisbane Water. This indicates that DECC's targets are relatively effective in reducing pollutant loads for TP and TN from intensified residential areas such that the current loads are not exceeded.

9.4 Scenario 4

Scenario 4 incorporated 16 regional treatment devices into the Scenario 3 MUSIC Model, including GPTs (assumed to be CDS Units), Bioretention Systems, Rainwater Tanks and Treatment Trains combining all three device types. The 16 regional treatment devices directly relate to the relevant Management Options presented in the Brisbane Water EMS.

Scenario 4 indicates that the implementation of these regional treatment devices throughout the Brisbane Water catchment would reduce TSS, TP and TN annual pollutant loads to Brisbane Water Estuary by 5.1%, 2.9% and 1.9% respectively (**Table 8.4**), compared with Scenario 3 results.

All of the standalone GPT devices modelled drain directly to Brisbane Water. **Table 8.4** indicates that generally these GPT devices, when used alone, are not effective in reducing TP and TN loadings and only reduce TSS loadings by a minimal amount. The most substantial reduction in pollutant loads is evident in Woy Woy Creek, which drains to Correa Bay. These results are due solely to Management Option W04, which incorporated a standalone Bioretention System to treat stormwater from the Bulls Hill Quarry site.

9.5 Scenario 5

The top five most effective regional treatment devices from Scenario 4 were selected for incorporation into the Scenario 5 MUSIC Model. An analysis of the treatment efficiencies of the devices and the incoming pollutant loads being treated was undertaken (**Table 7.1**) and indicated that the Bulls Hill Quarry Bioretention System (Management Option W04) was the

most effective treatment device of those evaluated, followed by the multi-device Treatment Trains 2, 4 8 and 9 (Management Option W01). These types of WSUD features are able to treat nutrients (TP and TN), as well as suspended solids (TSS).

Scenario 5 indicates that the implementation of these top five most effective regional treatment devices throughout the Brisbane Water catchment would reduce TSS, TP and TN annual pollutant loads to Brisbane Water Estuary by 3.8%, 2.2% and 0.9% respectively (**Table 8.5**), compared with Scenario 3 results.

When analysed on an overall basis this change may not appear significant, but when the results are considered on a more localised level, focusing on pollutant loads to the major tributaries of Brisbane Water, much more substantial reductions are tangible. For example results for the Bulls Hill Quarry Bioretention System indicate a reduction in TSS, TP and TN loads by 41.7%, 15.4% and 9.7%, respectively for that catchment (**Table 8.5**), which is a significant local reduction in pollutant loading.

9.6 Relationship Between Catchment Loads and Estuary Responses

The relationship between catchment loads and estuary response, in terms of estuarine hydraulic processes, morphology and siltation, and water quality processes, was considered explicitly using DELFT3D modelling for the *Brisbane Water Estuary Processes Study* (Cardno, 2008). Whilst MUSIC modelling was undertaken to evaluate catchment loads, no further DELFT3D modelling was undertaken for this report to explicitly consider estuarine responses. Instead, these responses have been inferred from the previous DELFT3D modelling.

The results of the DELFT3D modelling are presented in full in the Estuary Processes Study (Cardno, 2008). The relevant key findings of this DELFT3D modelling and any impacts/changes to this modelling as a result of the MUSIC modelling undertaken in this report are discussed below.

Flushing Times and Water Quality: Flushing of the Brisbane Water Estuary is generally complex, being of relatively short duration at locations strongly influenced by tides (such as The Rip and Ettalong), and longer in areas further upstream and in embayments. Flushing is the primary control on water quality through the dispersion and dilution of pollutants and promotion of mixing (Cardno, 2008). For example, DELFT3D modelling determined that the Gosford Broadwater has a flushing time of up to 30 days. Narara Creek, which flows to the Gosford Broadwater, is a major source of nutrients and suspended solids (**Section 8**). Therefore, water quality in the Gosford Broadwater may be compromised in this location due to the coincidence of elevated catchment loads and relatively long flushing times. Nonetheless, water quality data analysis in the Estuary Processes Study (Cardno, 2008) indicated a general trend towards water quality improvement in more recent years, although whether this is due to catchment based controls or changing rainfall patterns (i.e. drought) is unclear.

Sediments and Sedimentation: Estuarine geomorphology is a result of interactions between catchment inputs and coastal/estuarine processes. Bed sediments may be sourced from catchment inflows (fluvial) or marine inputs. The present rate (with existing GPTs) at which sediments are delivered to the Estuary was determined in Scenario 1 to be

approximately 5.6 million kg/year (**Table 8.1**). Where land use changes occur in the catchment, such as the proposed Somersby industrial development, the annual load of sediment inputs from the catchment may be affected. Industrial sites generally have high impervious areas and hence larger runoff. However, if stormwater treatment devices are used effectively, increased sediment loads can be mitigated. Scenario 3 indicates that, with DECC (2007) targets in place and new developments and residential intensification by 2030, this sediment delivery rate could by reduced to approximately 5.3 million kg/year (**Table 8.3**), if effective stormwater treatment devices are incorporated. The proportional contributions of the major tributaries and sub-catchments that drain directly to Brisbane Water are indicated in **Section 8**.

Heavy Metal Contamination: Human activities can impact on the quality of sediments via the introduction of a range of pollutants, including heavy metals. The Estuary Processes Study (Cardno, 2008) identified that lead, copper and zinc were present in the highest concentrations. These metals are associated with roads and some industrial activities. The most significant source of heavy metal contaminants appeared to be Narara Creek, followed by Erina Creek (Cardno, 2008). These results concur with the MUSIC catchment modelling results for TSS, as indicated in **Section 8**. The results are consistent with land use, high runoff volumes, high concentrations of contaminants and larger sizes of the respective sub-catchments. Heavy metal contamination is most pronounced in the northern reaches of the Brisbane Water Estuary (Cardno, 2008). The implications of heavy metal contamination for the scenarios considered are further discussed under Ecological and Recreational Impacts.

Transient Conditions and Wet Weather: DELFT3D modelling (Cardno, 2008) showed that TP and TN introduced to the Estuary by freshwater inflows were generally found to exhibit similar characteristics, with a noticeable stratification effect in nutrient concentrations related to freshwater flows overlying saline flows. Tidal flows are one of the primary factors governing mixing and flushing in estuarine environments. DELFT3D modelling (Cardno, 2008) showed that in the lower reaches of the Estuary (Paddy's Channel, Lintern Channel, St Hubert's Island, The Rip, Entrance Channel and Pretty Beach) nutrient concentrations fluctuated with the tides and waters appeared well mixed with little difference between surface and bed waters. These results concurred with the findings relating to flushing times of the different parts of the Estuary; flushing times for locations south of The Rip were of the order of 2 to 3 days (Cardno, 2008).

Analysis of water quality data in the Estuary Processes Study found that in 2001 and 2002, the highest nutrient concentrations were observed at Narara, Erina and Kincumber Creeks, which is consistent with MUSIC catchment modelling for all Scenarios. Narara and Erina Creek also recorded higher average nutrient concentrations in 2006 and 2007 (Cardno, 2008). However, Woy Woy and Cockle Creeks also appear to be important sources of TN and TP. In general, Booker Bay has lower average nutrient concentrations, likely due to higher rates of flushing at this location by marine water (Cardno, 2008). The implications of elevated nutrient concentrations for the scenarios considered are further discussed under Ecological and Recreational Impacts.

Ecological and Recreational Impacts: Based on the water quality data used to assess ambient water quality in the Estuary Processes Study (Cardno, 2008), as well as modelling

of transient conditions, it is apparent that water quality is an issue for the Brisbane Water Estuary, particularly with respect to nutrient and sediment inputs and heavy metals. MUSIC modelling undertaken for this report indicated no significant changes to TSS, TP and TN inputs into Brisbane Water by 2030 (Scenario 3), indicating approximately a 5%, 3% and 1% decrease for TSS, TP and TN loads delivered to Brisbane Water respectively (**Table 8.3**). As heavy metals are generally associated with finer particles, they are likely to enter the Brisbane Water Estuary attached to fine suspended solids (TSS). Hence, under Scenario 3, an associated minor decrease in heavy metal loads may be inferred from a minor overall decrease in delivered TSS loads.

Climate Change Scenarios: A comparison between wet and dry years in the Estuary Processes Study (Cardno, 2008) suggests that predicted changes in rainfall patterns may lead to a decline in water quality (e.g. wetter periods are likely to result in higher loads of pollutants delivered to the Estuary, while dryer periods will result in lower loads of pollutants delivered to the Estuary). Overall, the future rainfall predictions vary for climate change, but CSIRO and BoM (2007) indicates an average annual reduction in rainfall.

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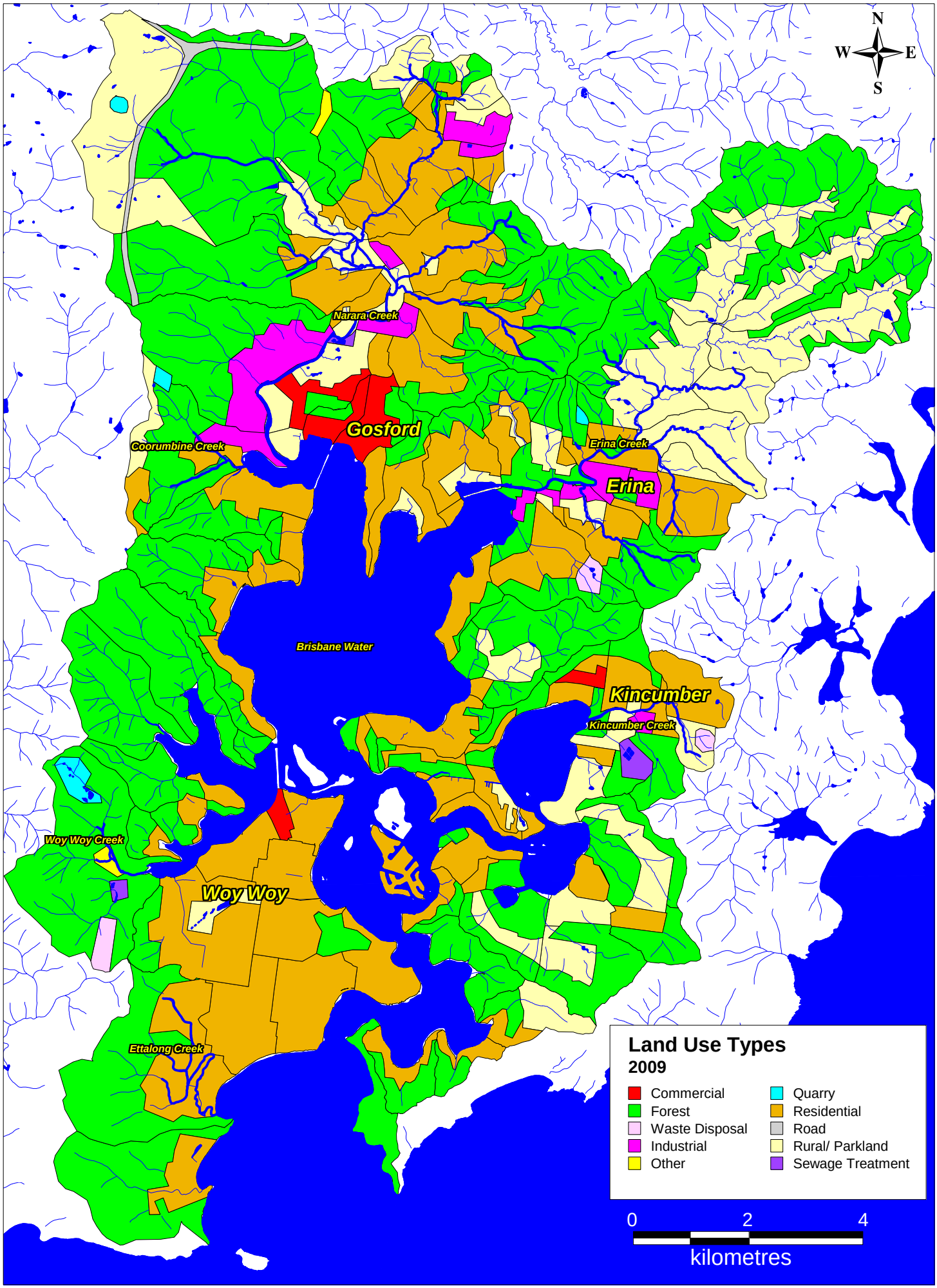
Figures



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Brisbane Water
Estuary Management Study

FIGURE 1
Estuary Processes Study MUSIC Model
Layout and Sub-Catchments

LJ2717 - Brisbane Water EMS&P\Figures\MUSIC Report\Figure 1

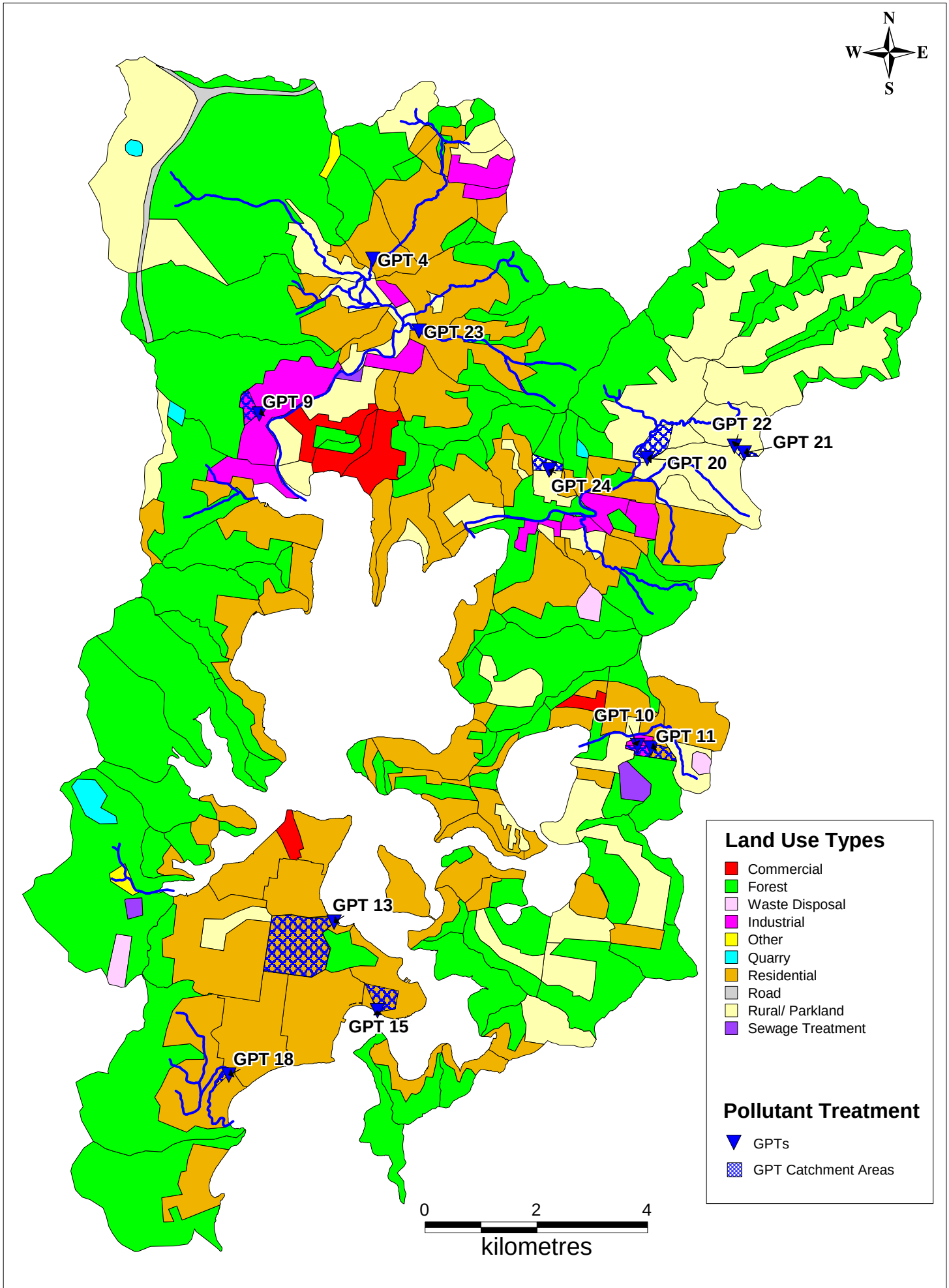

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FIGURE 2
Scenario 1 - GPTs and
GPT Treatment Areas

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LJ2717 - Brisbane Water EMS&P\Figures\MUSIC Report\Figure 2

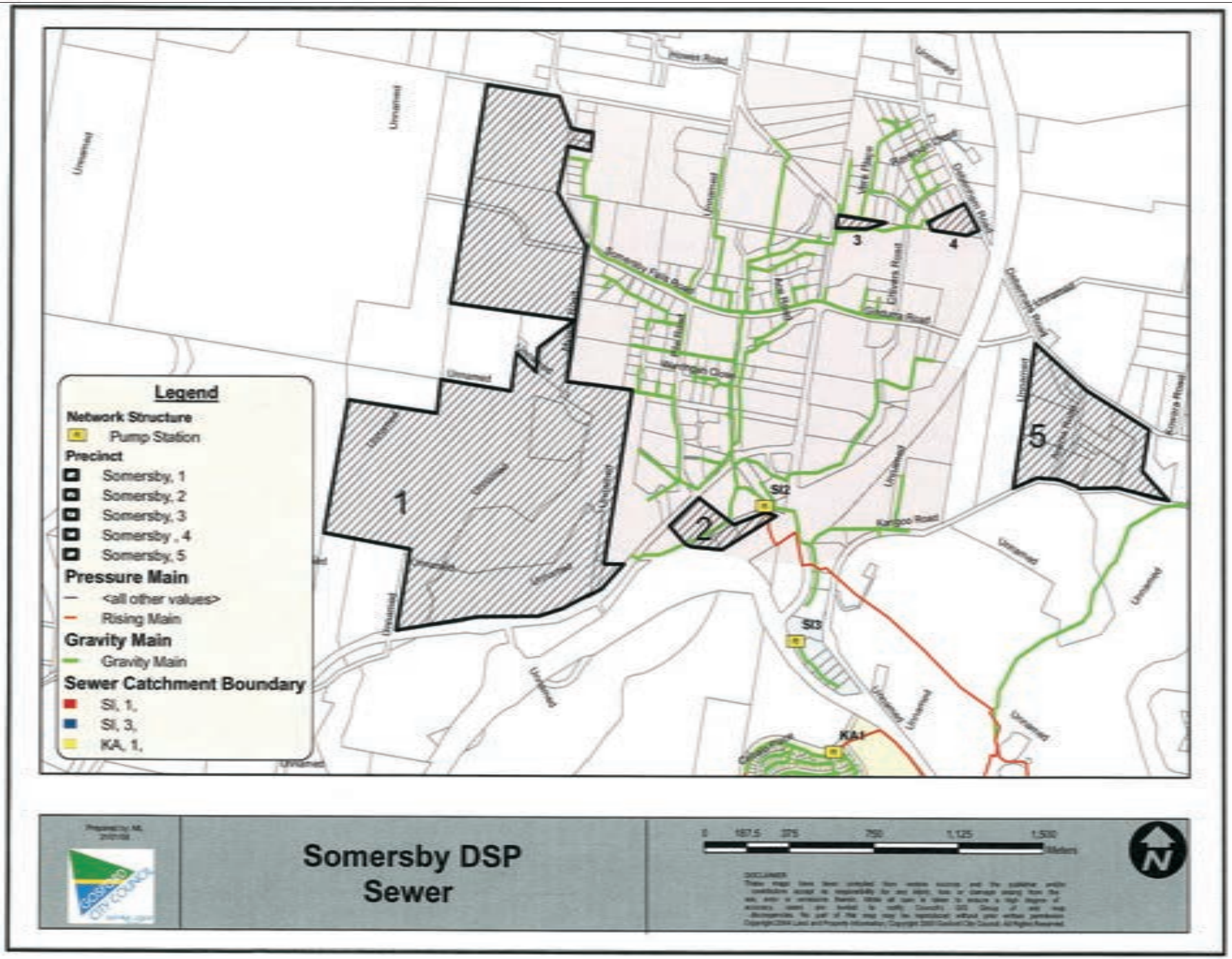

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FIGURE 3
Proposed Somersby Industrial Development

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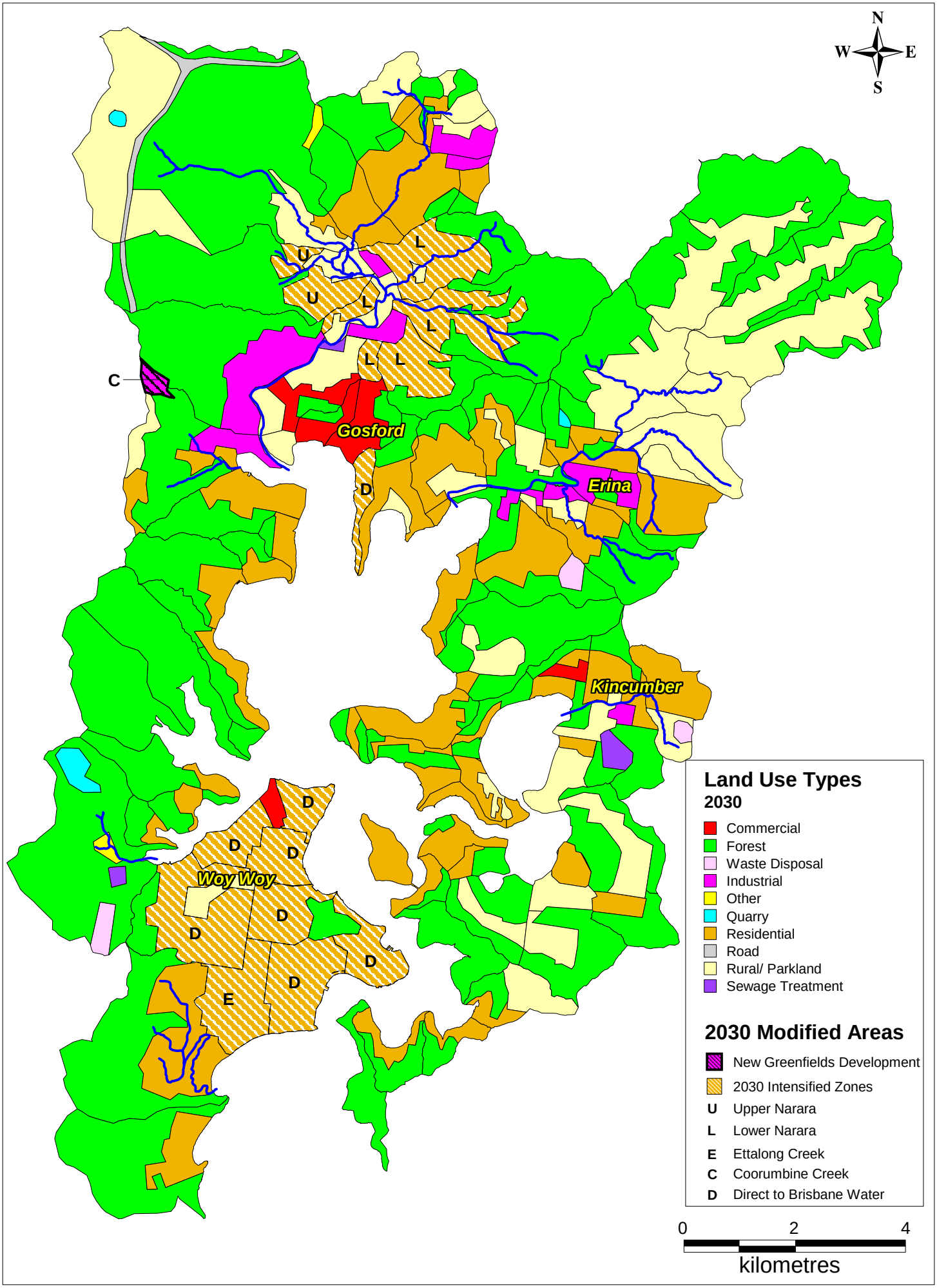

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FIGURE 4
Scenario 2 - Intensified Residential
Sub-Catchments and New Development by 2030

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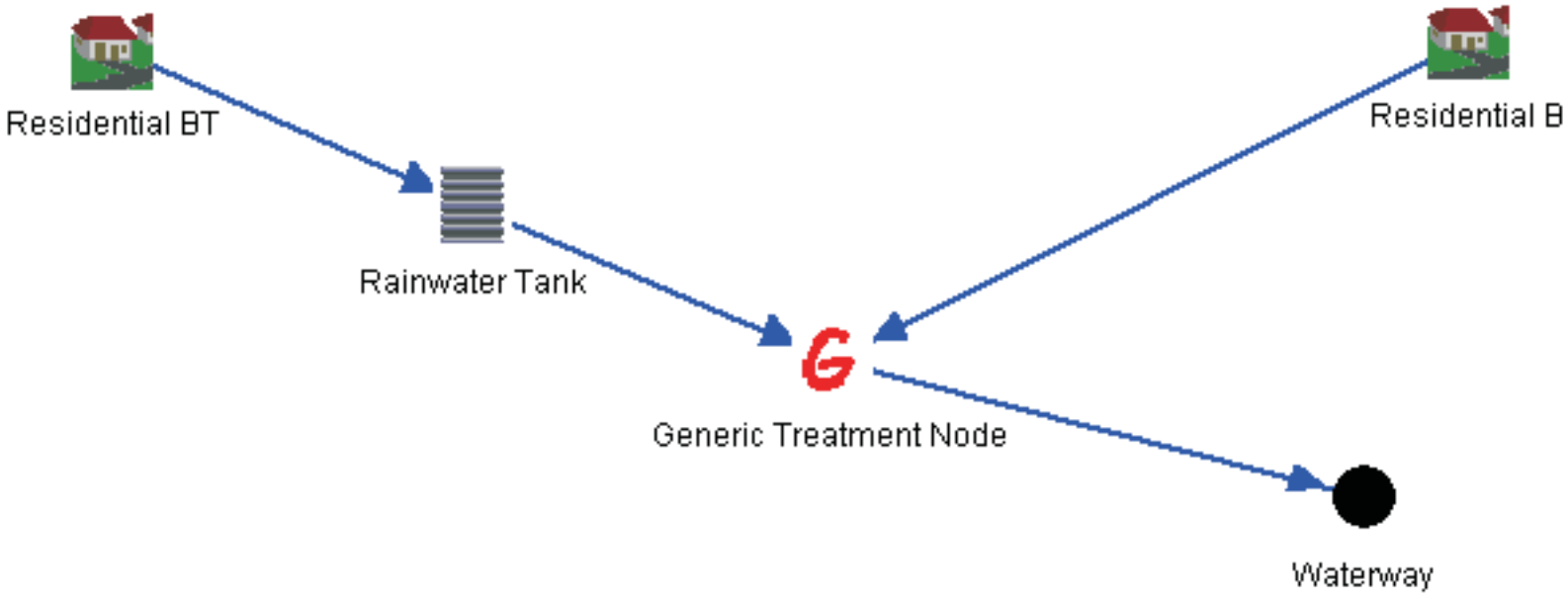

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FIGURE 5
Scenario 2 - Sample MUSIC Model Configuration

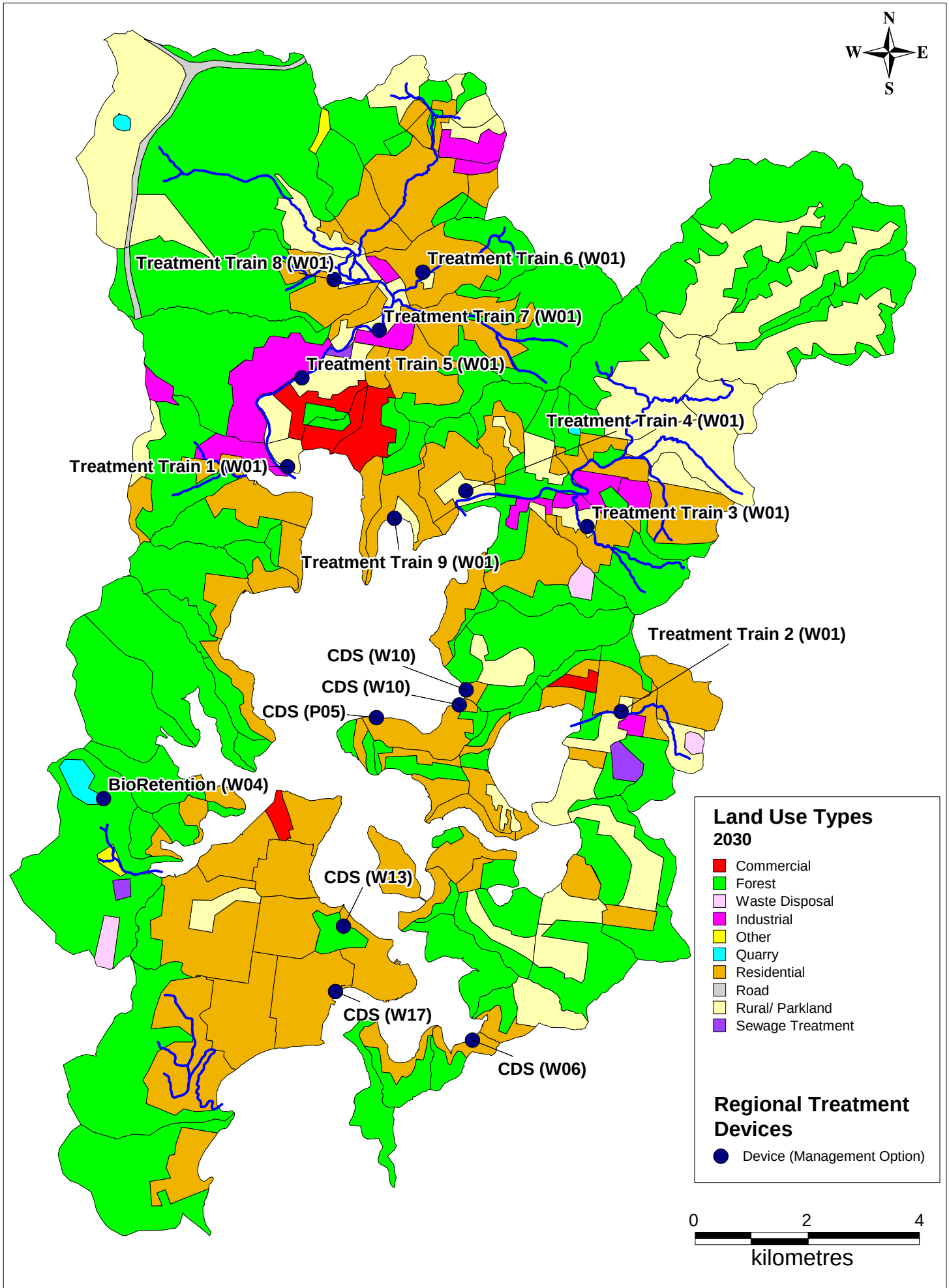

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FIGURE 6
Scenario 4 - Regional Treatment Devices
Full Suite Relating to Management Options

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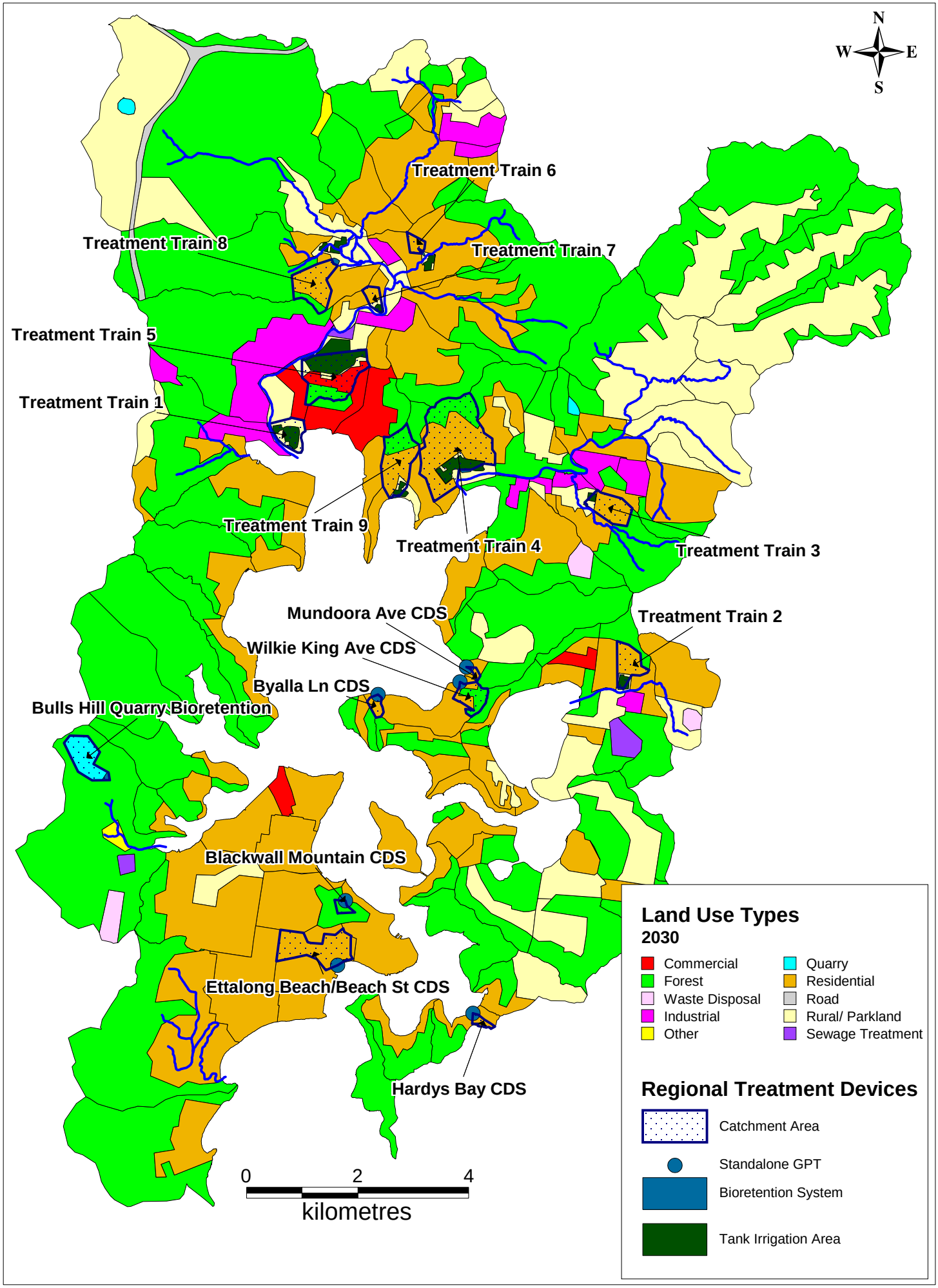

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FIGURE 7
Scenario 4 - Treatment Areas and Irrigation Areas for Regional Treatment Devices

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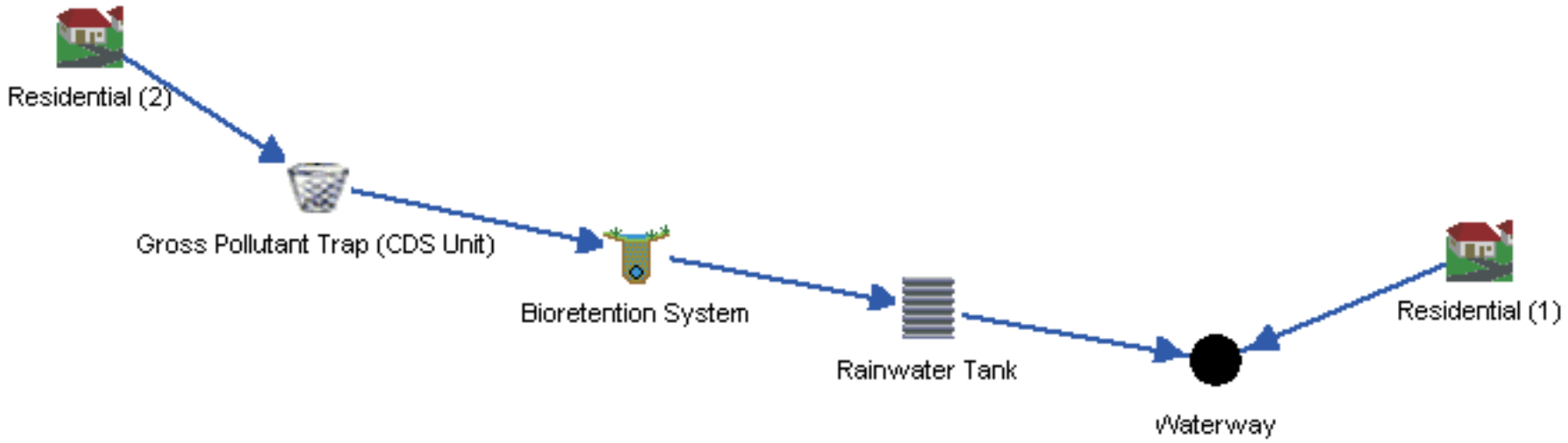

Brisbane Water
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FIGURE 8
Scenario 4 - Sample Treatment Train Configuration in MUSIC

Appendix G

CLAM Tool Report

Cardno LawsonTreloar
Shaping the Future

Brisbane Water Estuary Management Study

Dredging Options CLAMs Summary Report

LJ2712/R2598

Prepared for Gosford City Council*

16 October 2009

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Version	Status	Date	Author		Reviewer	
1	Draft	16 October 2009	Sean Garber	SJG	Tanja Mackenzie & Doug Treloar	TJM PDT

*Gosford City Council has prepared this document with financial assistance from the NSW Government through the Department of Environment, Climate Change and Water. This document does not necessarily represent the opinions of the NSW Government or the Department of Environment, Climate Change and Water.

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Appendices

1 Introduction

This report provides a summary of a series of Coastal Lake Assessment and Management (CLAM) models that have been developed for Gosford City Council (GCC) to investigate a range of dredging options within the Brisbane Water estuary. The CLAM model system is a Bayesian decision support tool developed by the Australian National University (ANU). The system was originally designed as a tool to assist in the management of small coastal lakes and lagoons by using a Bayesian (i.e. probabilistic) approach to investigating potential outcomes from specified management scenarios.

The CLAM tools have been prepared as part of the *Brisbane Water Estuary Management Study* (Cardno, 2009) and will inform the development of the Brisbane Water Estuary Management Plan (Cardno, forthcoming). The CLAM tools aim to assist Council in considering a range of different scenarios for implementing the dredging options identified in the Management Study and also by providing additional information to support the implementation of any specific dredging actions as part of the Estuary Management Plan.

A key issue in the Brisbane Water estuary system, as identified via community consultation, is navigation in the narrow, shallow channels of the various estuarine branches. These CLAM tools seek to analyse various options for dredging, incorporating environmental, social and financial considerations.

1.1 Project Background

Brisbane Water estuary has a relatively shallow waterway which, in combination with the popular usage of the waterway for recreational boating and fishing, has resulted in a range of issues relating to safe navigation for a number of channels within the estuary. Concerns over the need for maintenance dredging of these navigation channels have been raised with Council by a number of waterway user groups. GCC has recognised that dredging in Brisbane Water estuary for navigation purposes is a critical management issue in the short to medium term.

1.2 Coastal Lake Assessment and Management (CLAM) Tool

The CLAM tool has been developed by the ANU with the support of the Department of Environment, Climate Change and Water (DECCW) to assist in the management of coastal lagoons and estuaries. The CLAM tool is intended for use by local council and state government representatives to assist in applying a holistic approach to planning and decision making in the management of these systems in particular. CLAMs have been developed, or are under development, for 27 coastal lake catchments in NSW, with an increasing demand for the development of specific applications for the management of localised estuarine areas within a larger estuary.

The CLAM tool integrates existing knowledge on the ecological, social and economic functions of estuaries using a range of methods in such a way as to incorporate uncertainty (i.e. where knowledge gaps exist because of the complexity of physical and ecological processes within estuarine systems). When assessing a range of management options for estuaries (such as options for dredging), the CLAM tool identifies the likely trade-offs between ecological, social and economic values associated with the implementation of

those management options. In this way, the CLAM tool explicitly incorporates a triple-bottom line approach.

For the purposes of this study, the Dredging Options CLAM Tool comparatively assesses the social, economic and environmental impacts of the various dredging options for the Brisbane Water estuary within an objective framework. Further information on the CLAM tool and its applications can be found at the following websites:

http://icam.anu.edu.au/html/clam.html
http://www.dnr.nsw.gov.au/estuaries/factsheets/modellingtools/CLAM.shtml
http://www.dnr.nsw.gov.au/estuaries/factsheets/modellingtools/pdfs/Ticehurst_MODSIM05.pdf

1.3 Study Outline

Cardno Lawson Treloar has been commissioned by GCC to develop a series of Dredging CLAMs for seven separate locations within Brisbane Water. The purpose of these tools is to investigate dredging options as identified through the community and stakeholder consultation process (refer to Section 2.3 of Cardno, 2009). **Figure 1.1** shows the location of the estuary waterways, otherwise referred to as 'CLAM regions', proposed for dredging.

This study follows on from the application of the CLAM tool at two locations that were previously proposed for dredging (Cardno, 2008b). The previous CLAM tool was designed as a case study to investigate the suitability of the CLAM system for the future management of Brisbane Water estuary. Those two study sites considered in that CLAM tool, Gosford City and Entrance areas, were selected because they represent the upstream and downstream extents of the Brisbane Water estuary system and were therefore useful in determining the suitability of the CLAM tool for application to the whole of the Brisbane Water estuary. The case study proved the usefulness of these CLAM tools in assessing management options and Council subsequently commissioned the development of other CLAM tools (i.e. the current report) as part of the *Brisbane Water Estuary Management Study* (Cardno, 2009).

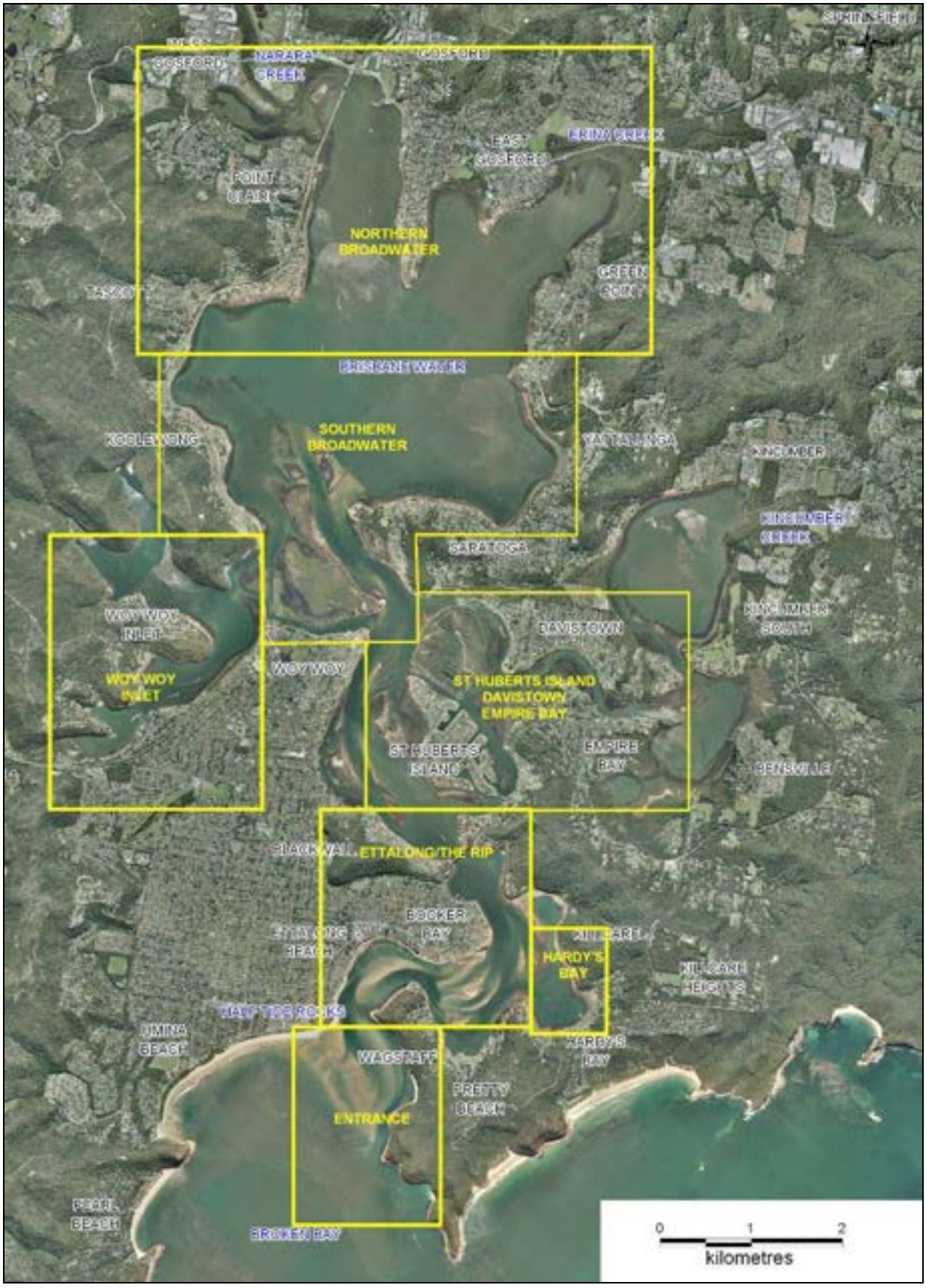

Figure 1.1: Estuary Waterways Proposed for Assessment with the Dredging CLAMs

2 Stakeholder and Community Consultation

2.1 Community Consultation

An extensive community consultation exercise was undertaken as part of the Brisbane Water Estuary Management Study to obtain community and stakeholder input into the navigation issues currently affecting the waterway and to identify dredging options for consideration as part of the Dredging Options CLAMs. Full details of the consultation program and outcomes are described in the *Estuary Management Study* (Section 2 of Cardno, 2009), of which this report is an appendix.

A full description of the consultation program and the outcomes of that process are provided in Cardno (2009).

General dredging related issues raised included:

- Overall concerns that the rate of siltation is increasing within Brisbane Water;
- Community representatives, DECCW and DII - Fisheries indicated that storage of dredge spoil and management of acid sulphate soils are important issues for any dredging proposal; and
- The potential impacts dredging may have on the hydrodynamics of the Brisbane Water estuary system. With specific reference to the entrance channel, Cardno (2007b) found that dredging in this location would have a negligible impact on the hydrodynamics of the system.

2.2 Stakeholder Consultation

In addition to consulting with the community, ongoing liaison with the relevant agency stakeholders has been undertaken.

As part of the development of the initial Dredging CLAM case studies, a stakeholder consultation activity was undertaken on 29 May 2007. Invited participants included government agencies, community representatives, boat users and local surfers. Details of this consultation have been described in Cardno (2009).

2.3 Consultation with the Committee

The Dredging CLAMs framework described in this report was presented to Council's Coastal and Estuary Management Committee on 4 August 2009. This presentation included a demonstration of the CLAM tool's function and discussion of its application.

3 Dredging Options

The Dredging CLAMs have been developed to investigate potential impacts associated with implementation of the dredging options identified in the Brisbane Water Estuary Management Study (Cardno, 2009).

This section of the report provides a brief outline for each of the dredging options proposed for the various waterways or CLAM regions mapped in **Figure 1.1**. Details are provided on the various dredging options proposed for each of the regions identified in **Figure 1.1**, including consideration of:

- The perceived site specific issues supporting the case for dredging;
- The exact location proposed for dredging;
- Estimates of the volume of material that would need to be dredged based on desired depth and configuration;
- The need for maintenance dredging;
- Whether the option would be a short (1-2 years), medium (3-5 years) or long term (5 years +) solution to the issue (i.e. is the option likely to be sustainable?); and
- Identification of any sensitive aquatic habitats in the vicinity of the proposed dredged area.

Following advice from NSW Maritime, it is suggested that internal navigable waterways of Brisbane Water estuary be maintained at 2m below ISLW. Therefore, all the dredging options that seek to improve navigability have adopted this design depth. Where a dredging option seeks to serve some other purpose (e.g. improved flushing), an alternative design depth has been considered.

Further details on the inputs to the Dredging CLAMs for each of these dredging options have been provided in **Section 4**.

The full details of these dredging options are included in the CLAM tool interfaces.

3.1 Northern Broadwater Dredging Options

Figure 3.1 shows the location of those dredging options identified in the Management Study (Cardno, 2009) that are located within the Northern Broadwater CLAM region, including:

- Gosford Boat Harbour (Option W115);
- Correa Bay Royal Volunteer Coastal Patrol (Option W25);
- Victory Parade, Tascott (Option W36); and
- Green Point Boat Ramp (Options W25 & W116).

Figure 3.1: Dredging Options and Seagrass Distribution - Northern Broadwater Dredging CLAM

3.1.1 Gosford Boat Harbour (Option W115)

Over the last 20 years a number of proposals have been considered to re-develop the foreshore of Brisbane Water adjacent to the Gosford Central Business District (CBD). One such proposal was the SuperShuttle Boat Harbour and Marina development, for which an Environmental Impact Statement (EIS) was prepared in 1999 (Patterson Britton and Partners, 1999). This proposal proposed the re-development of the Gosford foreshore to provide harbour facilities for a high-speed ferry between Sydney and Gosford. Included in the proposal was the development of a 150-berth marina. Full details of the development are presented in Paterson Britton and Partners (1999). The proposal required the dredging of 90,000m^3 of predominantly muddy sediment to provide the necessary depth for the ferry and other craft using the marina.

Ongoing planning is currently underway regarding the future of the Gosford foreshore and this may provide for the implementation of some of the components of the Boat Harbour development. A second Boat Harbour development is included in the CLAM which is based on the *Gosford Waterfront Strategy* (Taylor Cullity Lethlean, 2006). The dredging volume requirement with the second Boat Harbour development is estimated at approximately 120,000m^3. Maintenance dredging requirements are estimated at 10,000m^3 to 15,000m^3 per year.

The existing boat harbour area has also been identified as being in need of maintenance dredging. The current sea-bed levels are said to restrict yacht access to the harbour facilities. Option W115 proposes dredging down to -2mISLW in this area would require approximately 350m^3 of sediment to be removed.

3.1.2 Coastal Patrol Maintenance Dredging (Option W25)

The Royal Volunteer Coastal Patrol (RVCP) site at Point Clare is the base for water craft used by the RVCP, DII - Fisheries and NSW Maritime. The site features a fixed jetty and a channel which connects to the Brisbane Water.

The nearshore area in this region has been subject to ongoing siltation and the access channel has been dredged twice over the last 25 years. The last dredging of the channel occurred in 2000. The RVCP have identified the need for maintenance dredging to occur in the near future. Estimates of siltation depths which have developed since the last dredging campaign are up to 1m. It is estimated that 3,000 to 4,000m^3 of sediment would need to be removed to ensure accessibility for water craft.

Adjacent to the site DII - Fisheries have mapped significant aquatic habitat including *Posidonia australis* seagrass beds (**Figure 3.1**).

3.1.3 Victory Parade, Tascott (Option W36)

The community has identified that significant sediment build up has occurred at this location (**Figure 3.1**), which has resulted in restrictions to navigation. The community also considers that sedimentation at this location has encouraged the collection of garbage and weeds, and that this impacts on the amenity of the area by producing unpleasant odours. Dredging to a depth of -2mISLW has been suggested, which would require approximately 3,500m^3 of material to be dredged.

There are significant seagrass beds covering the majority of the potential dredge footprint.

3.1.4 Green Point Boat Ramp (Option W26 & W116)

Ongoing siltation has been identified in the vicinity of the Green Point boat ramp. This has restricted boat access and utilisation of the facility. Dredging down to a level of -2mISLW has been proposed, which would require 1,600m^3 of sediments to be removed. Seagrass beds are located in the vicinity of the boat ramp.

3.2 Southern Broadwater CLAM

Figure 3.2 shows the location of those dredging options identified in the Management Study (Cardno, 2009) that are located within the Southern Broadwater CLAM region, including:

- Paddy's Channel (Option W18 & W25);
- Saratoga Boat Ramp (Option W25);
- Saratoga Channel (Option W25); and
- Woy Woy Channel (Option W117).

Figure 3.2: Dredging Options and Seagrass Distribution within the Southern Broadwater CLAM

3.2.1 Paddy's Navigation Channel (Option W18 & W25)

Over many years sediment build up and apparent reduction in current speed has been reported for Paddy's Channel by the community. This has restricted the provision of safe boating navigation. This area is thought critical as it is the only access in and out of the Brisbane Water Broadwater area. The maintenance of a 50m wide navigation channel would rectify this problem. Dredging to a depth of -2mISLW has been assumed, which would require approximately 18,000m^3 of sediment to be removed. No seagrass beds are present within the channel alignment.

3.2.2 Saratoga Boat Ramp (Option W25)

Continuing siltation has been identified in the vicinity of the Saratoga boat ramp. This has restricted boat access and utilisation of the facility. Dredging down to a level of -2mISLW would require 1,500m^3 of sediments to be removed. Seagrass beds are located in the vicinity of the boat ramp.

3.2.3 Saratoga Channel (Option W25)

Currently the Saratoga Channel is heavily affected by siltation and is unsafe for navigation. A reduction in currents though the area has also been reported. Dredging down to a level of -2mISLW would require 16,000m^3 of sediments to be removed. No seagrass beds are located along the channel alignment.

3.2.4 Woy Woy Channel (Option W117)

Continuing siltation has been identified along the Woy Woy Channel. The community now considers that navigation is hazardous through this area. This has restricted boat access and easy passage to the Woy Woy area. Dredging down to a level of -2mISLW would require 12,000m^3 of sediments to be removed. Seagrass beds are located in the vicinity of the channel, but are unlikely to be directly disturbed by dredging of the channel.

3.3 St Hubert's Island/Davistown/Empire Bay

Figure 3.3 shows the location of those dredging options identified in the Management Study (Cardno, 2009) that are located within the St Hubert's/Davistown/Empire Bay CLAM region, including:

- Western Cockle Channel (Option W116);
- Lintern Channel (Option W18);
- Cockle Channel (Option W18 & W116);
- Davistown Boat Ramp (Option W25 & W116); and
- St Hubert's Island (Option W19).

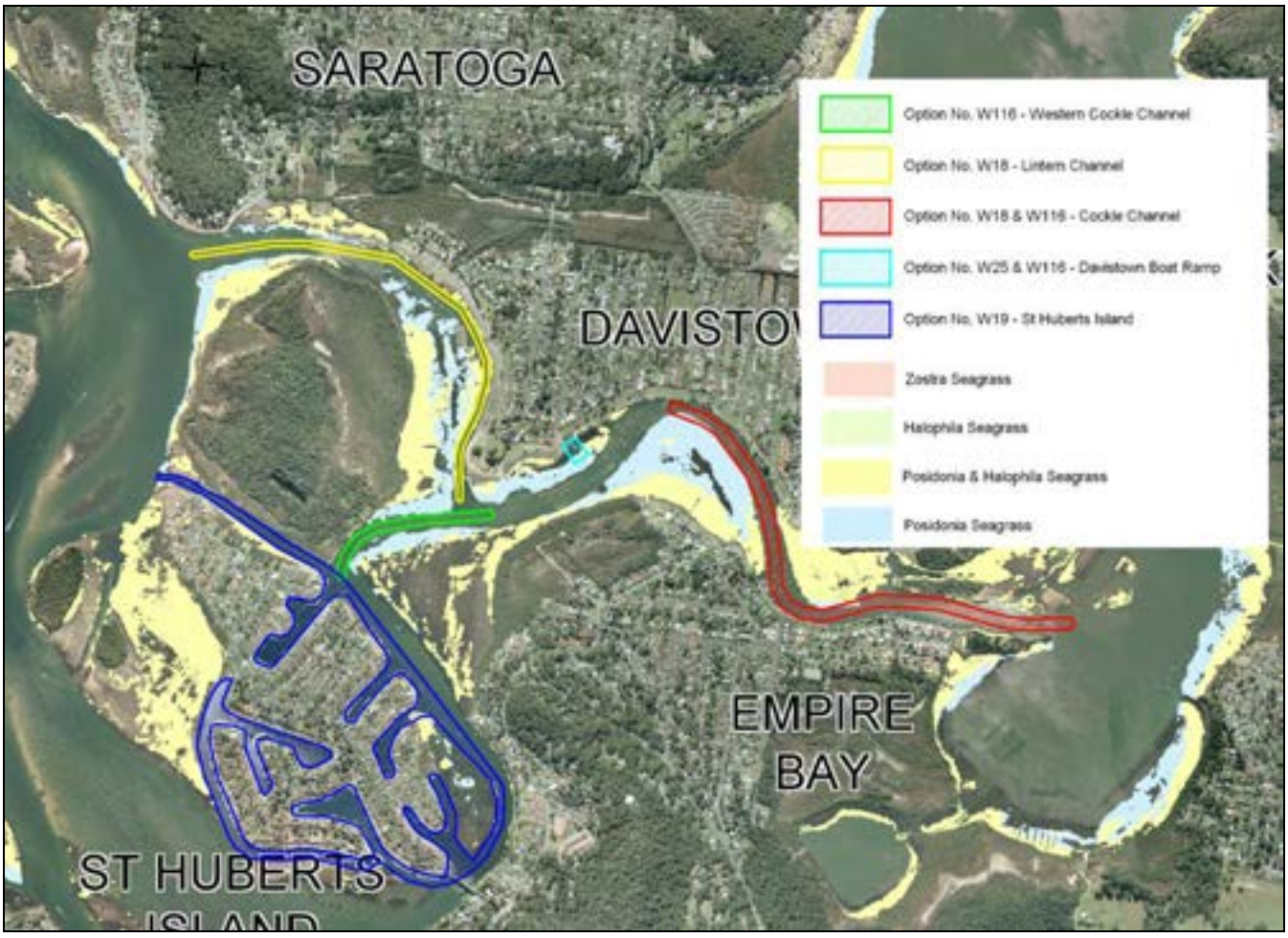

Figure 3.3: Dredging Options and Seagrass Distribution within the St Hubert's/Davistown/Empire Bay CLAM Area

3.3.1 Western Cockle Channel (Option W116)

Cockle Channel is the only waterway access passage to Kincumber Broadwater and Cockle Bay. Bar migration across the western end of Cockle Channel has been identified as resulting in a navigational hazard. Dredging of this area would require 8,500m^3 of sediment removal to achieve design depth.

3.3.2 Lintern Channel (Option W18)

The Lintern Channel is a narrow stretch of waterway separating Rileys Island from the Davistown/Saratoga area. It is utilised by boats travelling to and from the Davistown, Empire Bay and Kincumber areas.

3.3.3 Cockle Channel (Option W18 & W116)

As discussed above the Cockle Channel is a critical waterway in providing access to Kincumber Broadwater and Cockle Bay. Community consultation identified that medium sized craft (1m draft) cannot pass through the eastern end below half tide. Dredging of this area would be required to re-establish full time long-term navigability of the channel. Approximately 6,000m^3 of dredging would be required to establish a 30m wide channel.

3.3.4 Davistown Boat Ramp (Option W25 & W116)

Continuing siltation has been identified in the vicinity of the Davistown boat ramp. This has restricted boat access and utilisation of the facility. Dredging down to a level of -2mISLW would require 1,000m^3 of sediments to be removed. Seagrass beds are located within the proposed dredging footprint.

3.3.5 St Hubert's Island (Option W19)

The residents of St Hubert's Island have seen the slow infill of the canal system over the years and have campaigned to have the canals dredged to their original design depths. This would improve navigation through the system, providing ease of access to the foreshore properties. Some seagrass beds have colonised these canals and would be directly disturbed by dredging of these areas.

3.4 Woy Woy

Figure 3.4 shows the location of those dredging options identified in the Management Study (Cardno, 2009) that are located within the Woy Woy CLAM region, including:

- Boat Access. Horsefield Bay (Option W118);

3.4.1 Horsefield Bay Boat Access (Option W118)

Local residents and boat users have identified siltation as a cause of restricted access to shoreline areas of Horsefield Bay. Small dredging campaigns may improve this access and would require approximately 3,000m^3 of sediments to be removed to achieve reasonable depths.

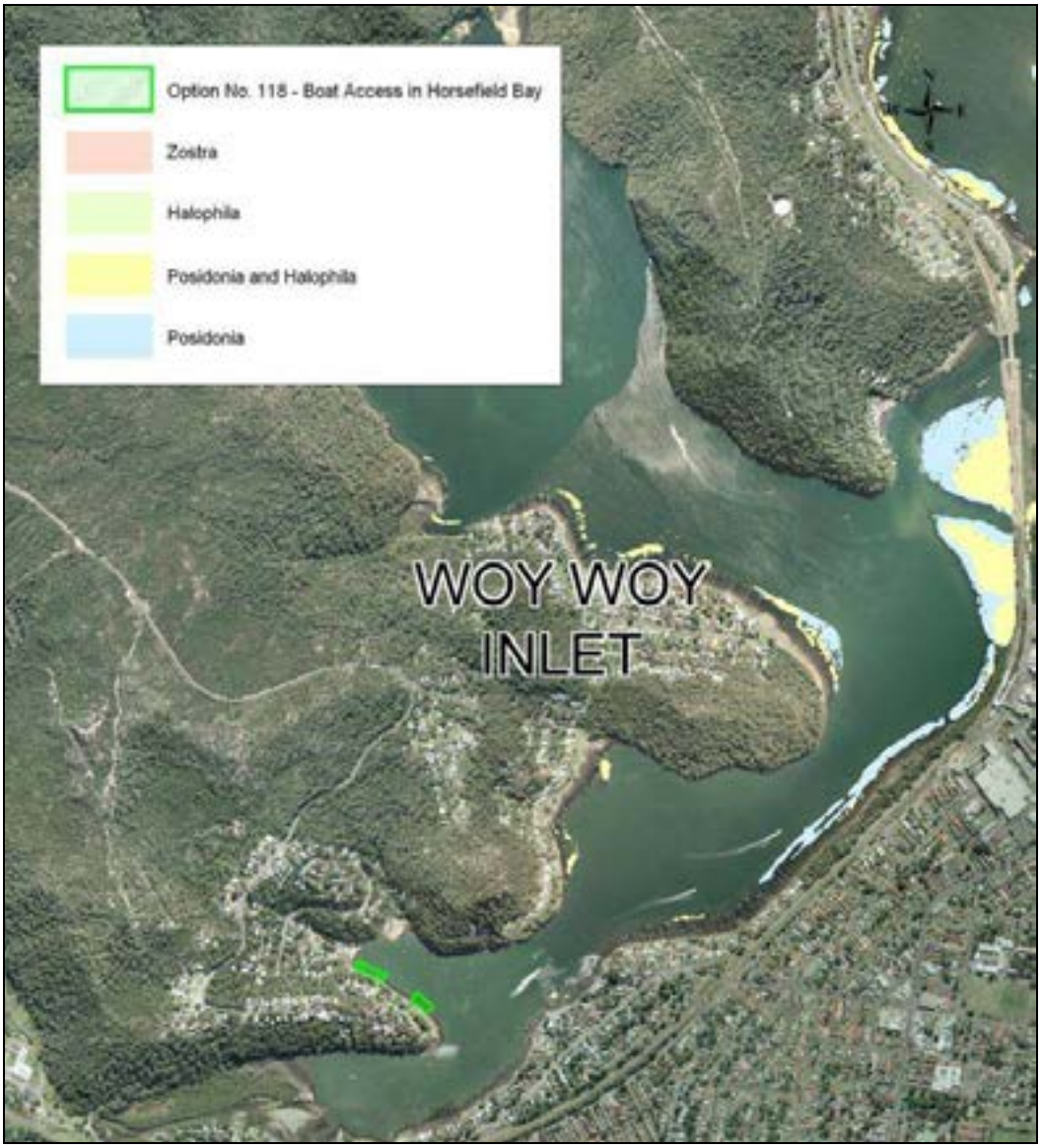

Figure 3.4: Dredging Options and Seagrass Distribution within the Woy Woy CLAM Area

3.5 Ettalong/The Rip

Figure 3.6 shows the location of those dredging options identified in the Management Study (Cardno, 2009) that are located within the St Hubert's/Davistown/Empire Bay CLAM region, including:

- Navigational Channel, Ettalong Shoals (Option W18);
- Navigational Channel, East Ettalong (Option W119); and
- Mulhall St, Wagstaffe (Option W119).

Figure 3.6: Dredging Options and Seagrass Distribution within the Ettalong/The Rip CLAM Area

3.5.1 Navigational Channel, Ettalong Shoals (Option W18)

Navigation through the Ettalong area is impeded by the highly mobile shoal system that extends from Brisbane Water entrance at Half-Tide Rocks up to Booker Bay in the north. Maintenance of navigation channels through this area has been highlighted as a community priority to improve safety and encourage boat usage of the estuary. Dredging of a channel 50m wide down to a level of -2mISLW would require 11,000m^3 of sediments to be removed. No seagrass beds would be expected to be located in such a dynamic shoal area.

3.5.2 Navigational Channel, East Ettalong (Option W119)

As discussed above, the maintenance of safe navigation is seen as an important management objective to promote the use of Brisbane Water Estuary. Dredging of a channel 50m wide down to a level of -2mISLW would require 20,500m^3 of sediments to be removed. No seagrass beds would be expected to be located in such a dynamic shoal area and none have been mapped in this location by DII - Fisheries.

3.5.3 Mulhall St, Wagstaffe (Option W119)

Local residents have noted hazardous navigation conditions in the vicinity of Mulhall St, Wagstaffe. A small dredging campaign may improve navigability and therefore safety in this area. Preliminary investigations suggest a small amount of dredging, in the order of 4,000m^3, would provide adequate depth and improve safety. No seagrass beds have been identified along the Wagstaffe shoreline.

3.6 Hardy's Bay Dredging Options

Figure 3.8 shows the location of those dredging options identified in the Management Study (Cardno, 2009) that are located within the Hardy's Bay CLAM region, including:

- Hardy's Bay Entrance (Option 25);
- RSL Creek Entrance (Option 25);
- Mudflat Creek Entrance (Option 25);
- Entrance to Riley's Bay (Option 121); and
- Killcare Marina (Option 120).

Figure 3.8: Dredging Options and Seagrass Distribution - Hardy's Bay Dredging CLAM Area

3.6.1 Hardy's Bay Entrance (Option 25)

The entrance to Hardy's Bay is defined as the connection between the main Brisbane Water Channel and the embayments of Hardy's and Riley's Bay. The area is dominated by large sand shoals that are shaped and formed by the flood and ebb tides. Local residents have raised concerns in regard to a reported deterioration in Hardy's Bay water quality in recent years.

The dredging described by this scenario is designed to improve the flushing and water quality of Hardy's Bay. This option proposes to dredge the estuary bed to -2mISLW to improve the conveyance of tidal waters through the entrance. The dredging volume required to establish this design depth is 25,000m^3 based on available bathymetric information. Ongoing regular maintenance dredging would be required to maintain these design depths.

Sandy sediment occurs in this location and there are no known seagrass beds present.

3.6.2 RSL Creek Entrance (Option 25)

The entrance of RSL Creek into Hardy's Bay is dominated by a large mudflat area predominantly formed by fluvial sediments. Local residents have raised concerns in regard to a reported deterioration in Hardy's Bay and creek water quality and the increase in the extent of mangrove trees; the latter reportedly arising from increasing siltation rates and inter-tidal flat progradation.

The dredging described by this scenario is designed to provide medium term improvement to the flushing and water quality of RSL Creek. To address this issue, a 10m wide channel dredged to -1mISLW has been put forward as a management option. A channel of this depth will provide constant tidal flushing of lower RSL creek over the full tidal cycle. The dredging volume required to establish such a channel is 4,450m^3. Ongoing maintenance dredging would be required.

The dredged channel would pass through an area of *P. australis* seagrass beds at its eastern end.

3.6.3 Mudflat Creek Entrance (Option 25)

The entrance to Mudflat Creek into Hardy's Bay is dominated by a large mudflat area predominantly formed from fluvial sediments. Review of available historical aerial photography shows that the course of Mudflat Creek through the mudflat shoal has changed over time and that the extent of bay siltation has developed further westward by about 30m to 40m over the period 1976 to 2004. Local residents have raised concerns in regard to a reported deterioration in the water quality of Mudflat Creek. In addition, there has also been reported an increase in the extent of mangrove trees, thought to be due to increasing siltation rates and intertidal flat progradation. Although there is anecdotal evidence from local residents that GCC has undertaken maintenance dredging to provide navigational access (or at least relocated sediments by side-casting), GCC were not able to locate any records of such activities.

The dredging proposed under Option 25 is designed to provide a medium term improvement to the flushing and water quality of Mudflat Creek. In order to achieve these

objectives, a 20m wide channel dredged to -1mISLW is proposed. A channel of this depth will provide tidal flushing of lower Mudflat Creek over the full tidal cycle. The dredging volume required to establish such a channel is 7,400m^3. Ongoing maintenance dredging would be required.

The dredged channel would pass through an area of *P. australis* seagrass beds at its western extent.

3.6.4 Entrance to Rileys Bay (Option 121)

The entrance to Rileys Bay is a 500m long and 70m wide channel that provides navigable access from Hardy's Bay. The channel is separated from the main Brisbane Water estuary waterbody by a large sand spit formation over an area of disused oyster leases. Public consultation has identified that blockage of this channel is occurring due to siltation, and this is starting to restrict navigable access to and from Rileys Bay.

The dredging proposed under Option 121 has been designed to provide medium term improvement to the navigability of the channel. Following advice from NSW Maritime it is suggested that the internal navigable waterways of Brisbane Water be maintained at 2m below ISLW. Therefore, assessment of this dredging option has considered dredging to this depth. The dredging volume required to establish a 30m wide channel to a design depth of -2mISLW is 21,000m^3. Ongoing maintenance dredging would be required, although this would likely be infrequent.

The channel is lined by seagrass beds composed principally of *P. australis*.

3.6.5 Killcare Marina (Option 120)

The Killcare Marina is located on the southern shore of Hardy's Bay. This facility offers a range of services including mechanical and structural repairs (slipway services), boat hire and a free sewage pump-out, and also has berthing facilities for 23 boats. It is a heavily utilised facility for local boat owners, especially for the sewage pump-out station. Recently it has been noted that access to the marina is limited for larger vessels due to siltation and decreasing water depths. For this reason, Killcare Marina has been identified as an area by the community as being in need of dredging.

Option 120 has been designed to provide medium term improvement in terms of both access and boating safety for the marina. It also includes dredging works for the public wharf located immediately adjacent to the marina. The dredging volume required to establish design depths of -2mISLW at these sites is 3,900m^3. Ongoing maintenance dredging would be required, although likely infrequent (e.g. every 5-10 years).

The facilities are surrounded by seagrass beds, primarily *P. australis* and *Z. capricorni*, although there is limited occurrence of seagrasses within the proposed dredging profile.

3.7 Entrance Dredging Options

The Entrance Dredging CLAM has been developed to investigate the effects of potential dredging between the Entrance region and Wagstaffe Point. Currently the entrance navigation channel is located adjacent to the south-east shoreline between Half Tide Rocks and Little Box Head. The channel is not subject to regular maintenance dredging; however, infilling of the channel has been an issue periodically. In 2007 rapid infilling of the channel

occurred near Lobster Beach as a result of natural propagation of bedform feature across the shoal.

The Entrance Dredging CLAM considers three management scenarios for maintaining suitable navigation conditions in the entrance region; namely:

- ***Permanent Outer Channel*** - Maintaining the existing outer channel with specified minimum depths (i.e. 2.5m depth along the whole channel),
- ***Secondary Inner Channel*** - Establishing a secondary inner channel which can be used to separate recreational and commercial vessels, and
- ***SEPP35 Maintenance Dredging*** - Undertaking SEPP35 maintenance dredging on an ad hoc basis as critical navigation hazards arise.

Figure 3.9 presents the identified dredging options within the Entrance CLAM study area.

Figure 3.2: Dredging Options - Entrance Dredging CLAM Area

3.7.1 Permanent Outer Channel

The Outer Channel (current marked channel) has a nominal design depth of 2.5m at low water (ISLW); however, significant sections of the channel have low water depths closer to 2m.

This scenario involves formally establishing a 30m wide channel between Little Box Head and Half Tide Rocks with options for design depths of 2.5m or 3m at low water. The deeper depths would allow larger vessels to enter Brisbane Water estuary. The dredging volumes required to establish the Permanent Outer Channel are:

- -2.5m (ISLW) – 24,000m^3; and
- -3m (ISLW) – 40,000m^3.

Ongoing maintenance dredging would be required, principally near Lobster Beach.

The Outer Channel is surrounded by *H. australis* (80,000m^2) seagrass beds, with a small area of *Z. capricorni* (12,000m^2).

3.7.2 Secondary Inner Channel

The Inner Channel refers to a secondary navigation route which has been utilised historically and follows a path directly north-west from Lobster Beach. The channel passes directly over the active sand shoal and navigation is variable due to the mobile sand shoals. NSW Maritime has indicated that the current Outer Channel is a preferred navigation route due to its protection from breaking swell waves. In the event that the Outer Channel option is implemented, the Inner Channel could be maintained as an 'unlit' secondary channel that could be utilised by experienced boat users. Ferry operators view the Inner Channel as an effective way of separating commercial and recreational boat users and an option for improving general boating safety within Brisbane Water estuary. They would prefer to use the Inner Channel when conditions are suitable.

This scenario involves formally establishing a secondary channel with a design depth of 2.5m at low water. The establishment of a permanent Inner Channel would require significant ongoing maintenance dredging. The Inner Channel is predominantly located on a mobile sand shoal and there is little to no aquatic habitat on the seabed there.

3.7.3 SEPP35 Maintenance Dredging

In 2007 rapid siltation of the navigation channel near Lobster Beach occurred. A large scale sand wave (height 1 to 2m, wavelength ≈ 150m) propagating to the south-east deposited up to 1,700m^3 of sand per month over several months into the navigation channel. This constricted the navigation channel to only permit one-way vessel movements near Lobster Beach. This area is exposed to peak ebb tide currents in excess of 1.5m/s and it is dangerous for large vessels to idle in this area whilst waiting for other boats to pass in the opposite direction. The Land and Property Management Authority, together with GCC, is proposing to dredge up to 20,000m^3 of sand from the entrance channel and surrounding sand shoal under SEPP35. This dredging is designed to provide a short to medium term improvement in the usability and safety of the navigation channel. Historically, SEPP35 dredging has also occurred near Half Tide Rocks. Future SEPP35 maintenance dredging activities could be added to this scenario in the CLAM.

4 CLAM Framework and Data Population

All the Dredging CLAMs apply a common framework, such that the same range of impacts can be considered for the different dredging options at all locations. The models incorporate the following impact categories:

- Water and sediment quality;
- Sediment quality;
- Aquatic flora and fauna;
- Local revenue;
- Recreational amenity; and
- Cost of implementation (incorporating both capital and ongoing/maintenance costs).

4.1 Conceptual Framework

Figure 4.1 presents the conceptual framework for the Dredging CLAMs, incorporating those impact categories described above.

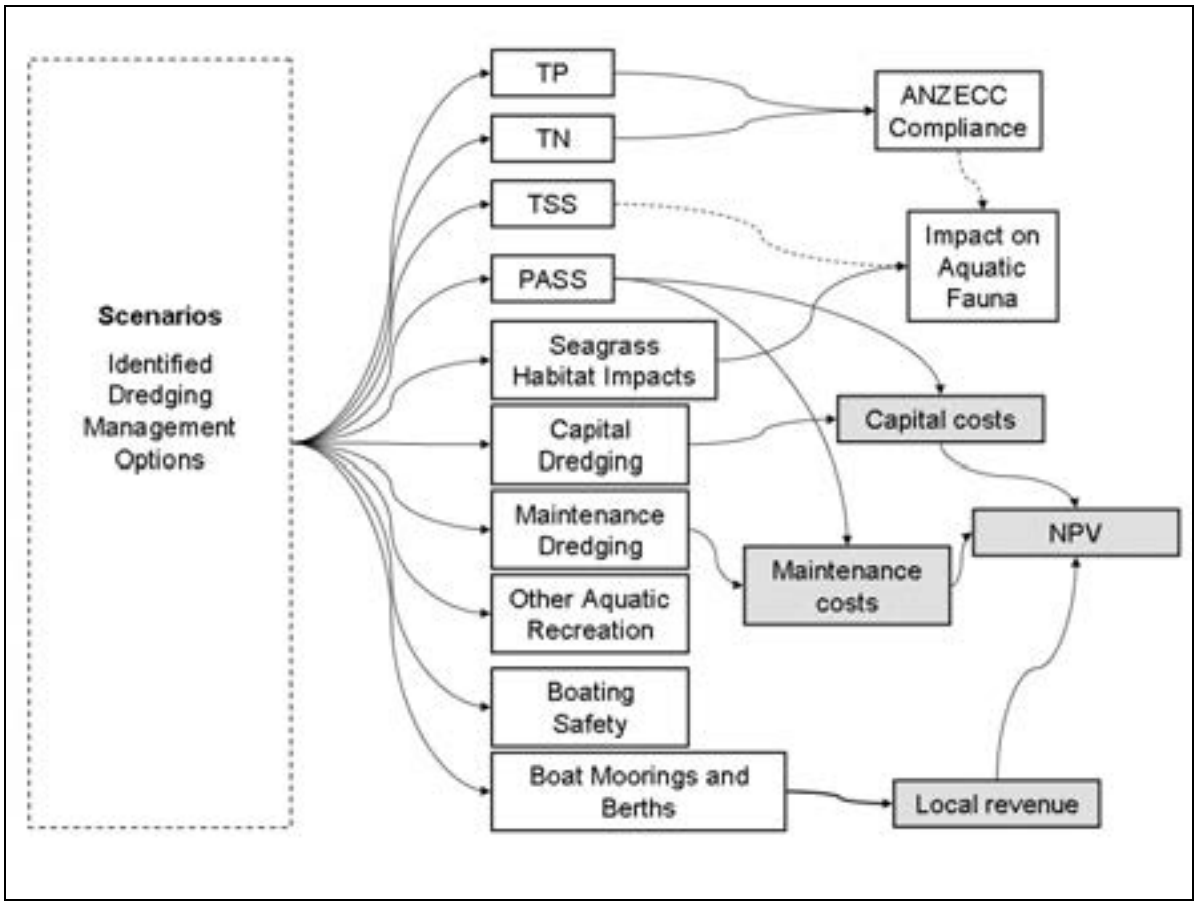

Figure 4.1: Dredging CLAMs Conceptual Framework

Each of the boxes represents a node in the CLAM framework. Details on each of the nodes are presented in **Appendix 1**. The solid connectors shown in the conceptual model (**Figure 4.1**) identify interactions which are explicitly represented in the CLAM. The dashed connectors identify interactions which have been considered in the development of the CLAM, but have not been specified in the model because of their relatively weak or indirect

interaction. In assessing the potential impact of the option on aquatic flora and fauna due to dredging, for example, indirect impacts (such as water quality impacts) have been included. However, generally speaking, the magnitude of potential water quality impacts has been assessed to be relatively small and would have minimal impacts on the wider ecosystem. Therefore the link was not explicitly represented in the CLAM model – see Section 4.4.

Wherever possible, each of the nodes shown in the conceptual model (**Figure 4.1**) is populated with data to inform the CLAM assessment.

4.2 Water and Sediment Quality Impact Assessment

The GCC Water Quality Database, which contains data from sampling sites in Brisbane Water estuary, has been used to make an assessment of the ambient water quality for the various CLAM regions. Total phosphorus (TP) concentrations are generally below ANZECC guidelines for estuarine waters (ANZECC/ARMCANZ, 2000) throughout the estuary. Total nitrogen (TN) concentrations in many areas of Brisbane Water estuary generally exceed ANZECC guidelines (ANZECC/ARMCANZ, 2000). However, adverse water quality outcomes are not commonly observed, for example, fish kills.

However, there is potential for sediment-bound nutrients stored within the seabed sediments to be released into the water column during dredging. Patterson Britton and Partners (1998) reported sediment samples from the Gosford Boat Harbour area had very high nutrient concentrations.

The calibrated Brisbane Water estuary Delft3D computer model developed for the *Estuary Processes Study* (Cardno, 2008a) has been used to investigate the transport and dispersion of nutrients released into the water column during dredging. **Figure 4.2** presents the peak tracer plume (i.e. the largest plume extent) from dredging within the Cockle Channel (Option W116).

Similar simulations have been undertaken for each dredging option in the Dredging CLAMs. The results from the Delft3D model have been used to estimate the changes for each dredging option in dissolved TN and TP likely to occur during dredging works. This data is incorporated into the CLAM tools as a percentage increase in average nutrient concentrations (TN and TP) during dredging works.

The Delft3D computer model was also used to investigate potential suspended sediment plumes that might occur during dredging. The Delft3D dredge plume modelling provided an indication of the increase in average near-bed suspended sediment concentrations during dredging works. **Figure 4.3** presents modelling results of peak near-bed suspended sediment concentrations for dredging at the Saratoga boat ramp site (Option W25). These can be considered representative of a 'worst case' scenario as they neglect the application of silt curtains and other systems that are applied for 'best practice' dredging operations. However, in general, these increases would be confined to a relatively small spatial area and would quickly disperse following the completion of each dredging period. Therefore, medium or long term impacts on concentrations of suspended solids are not anticipated.

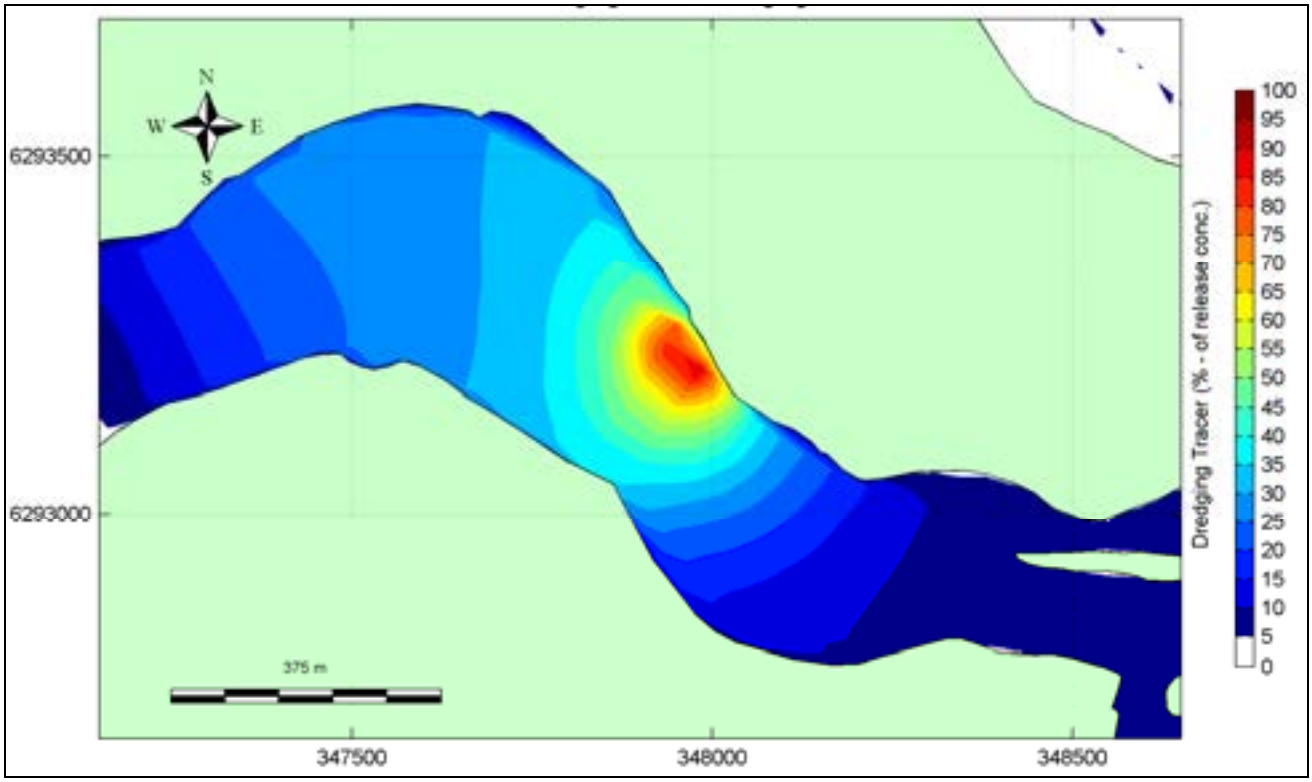

Figure 4.2: Peak Tracer Plume - Cockle Channel (Option W116)

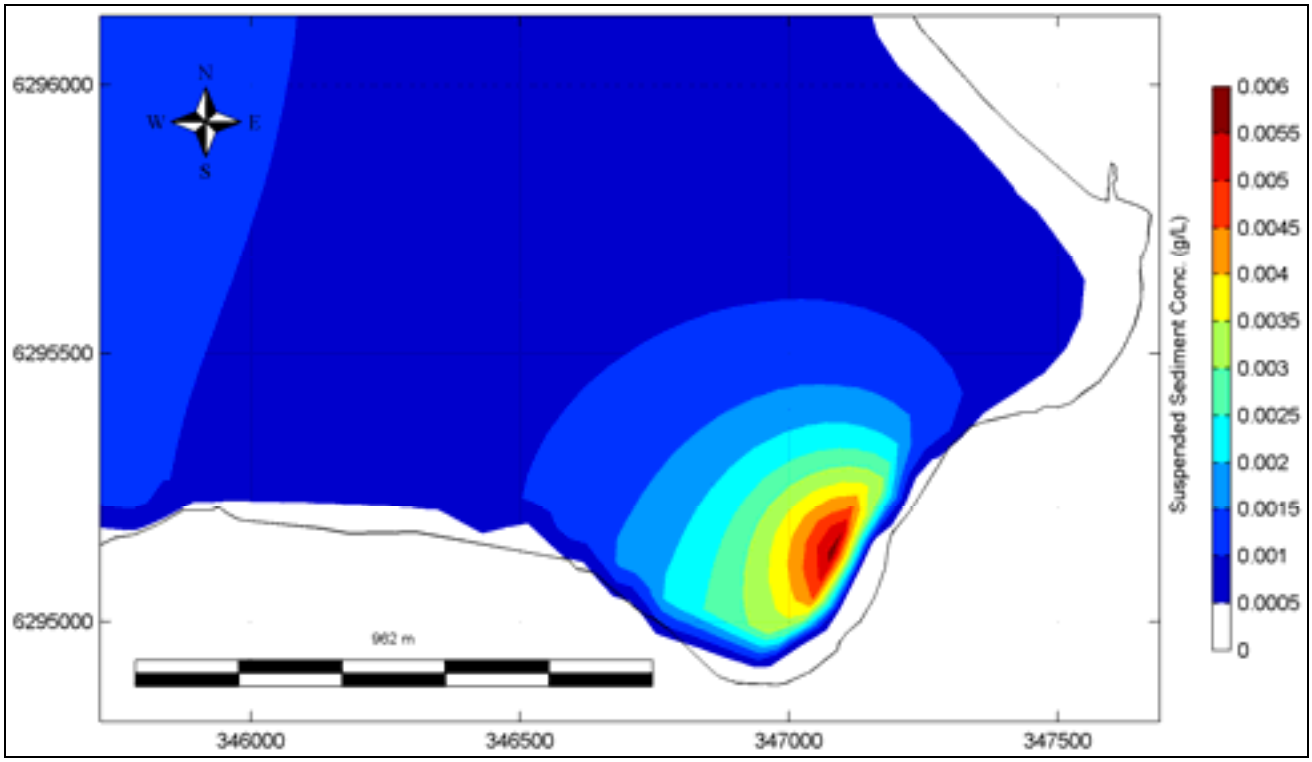

Figure 4.3: Peak Suspended Sediment Concentrations for (near bed) Dredging Plumes - Saratoga Boat Ramp (Option W25)

Heavy metal contamination is also an issue at some locations as noted in Cardno (2008a). Any dredging in such areas would need to minimise the potential for heavy metal mobilisation. These points are highlighted within each CLAM tool.

It is noted that, for the purposes of this assessment, it has been assumed that the dredge contractor will implement best practice environmental management and mitigation measures during the dredging works phase. Therefore, these water quality impacts are likely to be short in duration.

4.3 Aquatic Flora and Fauna Impact Assessment

Any potential impact on the wider ecology of the Brisbane Water estuary associated with the dredging options described in the CLAM will primarily be related to the loss of habitat, especially where this relates to the loss of seagrass beds. Therefore, the impact assessment for aquatic flora and fauna focussed primarily on impacts on seagrass beds.

It has been assumed that indirect impacts on flora and fauna will be captured through assessment of water and sediment quality impacts.

As part of the *Brisbane Water Estuary Processes Study* (Cardno, 2008a), GCC supplied Cardno Lawson Treloar with GIS data that included aquatic vegetation mapping (NSW Fisheries, 2003). **Figures 3.1-3.9** display the various dredging options and also incorporate the seagrass mapping from NSW Fisheries. The dominant seagrass species within Brisbane Water estuary are *Z. capricorni* and *P. australis*. *P. australis* seagrasses have been identified as being in decline in NSW estuaries and have therefore been considered as being more significant for the purposes of this assessment.

Depending on the particular footprint associated with a dredging option, the dredging option will either have a direct negative impact (i.e. loss of actual seagrass area though physical removal during dredging operations) or negative indirect impact on seagrass areas (e.g. due to water quality impacts during dredging operations).

The area of seagrass beds suffering direct impacts relative to the total area of seagrass beds in the surrounding areas was calculated for all dredging options. Consider, for example, the option for dredging of the RVCP area (Option W114) in the Northern Broadwater CLAM region. Implementation of this option would result in the loss of around 0.5% of the seagrasses present in the Northern Broadwater CLAM region. There are sizable seagrass beds located throughout the Broadwater area. It is assumed, therefore, that mobile fauna may migrate to seek refuge in nearby undisturbed seagrass beds. However, the loss of any *P. australis* seagrasses has been considered as being more significant (comparative to other seagrass species) due to the limited re-colonisation capacity of this species.

In summary, the wider ecological impact has been represented in the Dredging CLAM in terms of the impact on aquatic fauna biomass due to reductions in seagrass habitat extent. The relative loss of aquatic fauna biomass has been assumed to be directly proportional to the relative loss of seagrass habitat in the area.

Full details for each of the various regions are provided in the CLAM tool interfaces.

4.4 Social Impact Assessment

A range of social impacts have been incorporated in the CLAM, including:

- Impacts on recreational activities other than boating;
- Net impacts on boating safety, and
- Impacts on the number of boat moorings or berths in Brisbane Water.

These impacts were based on subjective assessments of the likely outcomes of each dredging activity.

The implementation of a particular dredging option may be deemed to result in either positive or negative impacts on other recreational users of Brisbane Water. For example, where dredging is considered likely to increase boat traffic to a certain part of the estuary, this will result in a positive impact for a small number of boating people, but at the expense of a larger number of recreational users (e.g. swimmers, paddlers). In this case, a net negative impact on recreational usage would be allocated. In contrast, a net positive impact may result where implementation of the option provides more broad benefits for a large number of user groups.

Similar impact assessments were undertaken for boating safety.

Irrespective of any dredging activities, projected population increases in Gosford and Woy Woy will likely result in a gradual increase in the number of boat users in Brisbane Water estuary. Any dredging activity could result in an increase in the number of boats that are moored or berthed in a particular region of the estuary.

4.5 Economic Impact Assessment

The economic impact assessment component incorporates the assessment of impacts on local revenue, as well as the cost of implementing the dredging option.

4.5.1 Cost of Implementation

Dredging costs have been based on a feasibility study prepared for dredging sediments at Lake Macquarie, which included costing for the setup of equipment, together with removal and treatment of organic sediments from nearshore areas of Lake Macquarie (WBM, 2004).

The initial setup cost outlined in WBM (2004) was estimated at $30,000 for a campaign of approximately 15,000m^3, which represents a cost of $2/$m^3$. Dredging and treatment requirements (including treatment of acid sulfate soils) were costed at $20.1 per m^3 (WBM, 2004). However, this included additional treatment requirements (i.e. for organic material) and, therefore, this value was re-adjusted to an assumed cost of treating acid sulfate soils (ASS) of $10/$m^3$. The cost of treating ASS is incorporated into the overall cost of implementation based on the likelihood of ASS occurrence.

For each dredging option, the cost of implementation has been estimated based on the cost of both capital and maintenance dredging works.

4.5.2 Impacts on Local Revenue

The economic benefits resulting from implementation of a dredging option may result in a change to the number of moorings located in the estuary. Due to the fact that dredging

works will facilitate improved access to many parts of the estuary, it is assumed that there would be a net increase in moorings for many of the dredging options.

The economic impact of establishing additional boat moorings in Brisbane Water estuary has been estimated based on tourism revenue for the Central Coast region. The NSW Regional Tourism Forum – 2002 estimated that there are approximately 4.6 million overnight and day visitors to the Central Coast per year, which generates $620 million of revenue for the local economy. Additional boat berths in Brisbane Water have been assumed to provide 4 additional tourists to the region. Each person (tourist) has been assumed to visit the region for 12 days per year. Based on these assumptions, the revenue benefit per tourist has been assumed at $135 per day.

4.5.3 Net Present Value

Implementation costs and local revenue impacts have then been included in a calculation of Net Present Value. This provides an indication of the economic benefit associated with any of the dredging options assuming a 30 year period of implementation. A discount rate of 6.35% was applied based on treasury recommendations. It assumes maintenance dredging would be undertaken every 5 years and includes the annual return from an increase in tourism revenue.

4.6 Discussion

The reader is directed to each of the individual Dredging CLAM tools for a review of the CLAMs themselves.

The CLAM tools do not identify a definitive 'result' as such. Rather, they permit a comparison of the relative impacts of different implementation scenarios in relation to each of the impact categories identified in **Sections 4.2-4.5**. Considering, for example, the case of Hardy's Bay, GCC may choose to investigate a range of different scenarios, such as:

- Implementing only Option W121;
- Implementing all three options relating to Option W25; or
- Implementing all five options (W25 (3), W120 and W121).

The CLAM tool allows Council to assess the relative impacts associated with each of these scenarios. For example, implementation of all five options may provide the greatest economic and recreational benefits relative to the other two scenarios, but come at the highest relative cost in terms of impacts on flora and fauna. In such a case as this, Council may wish to consider what the desired outcome is for this location: Is it a priority to improve water quality (i.e. via implementation of Option W25)? Or is improved boating amenity more important at this location (i.e. via implementation of Option W120)?

Resource limitations may also be a factor, in which case the CLAM tool can be used by Council to assess which Option (or combination thereof) provides the greatest net benefit for the least expenditure.

The Dredging CLAM tool may also be used to run scenarios incorporating more than one option (e.g. implementing all five options for Hardy's Bay), which may be considered in some regards to be a cumulative impact assessment.

In this fashion, the CLAM tool functions as a decision support tool.

The CLAM tools are currently being reviewed by Council and ANU. Discussion of the results will be expanded once these reviews are complete and the CLAM tools finalised.

5 Conclusions

The Brisbane Water Dredging CLAMs have been developed as a decision support tool to assist Council in:

- Presenting the dredging options to the community and stakeholders in a user-friendly format;
- Explicitly incorporating a triple-bottom line assessment into the consideration of the different dredging options;
- Prioritising the various dredging options identified in the Management Study (Cardno, 2009) for implementation; and
- Identifying a preferred method of implementation through more detailed consideration of the likely impacts associated with each option.

Due to the complex nature of estuarine processes operating within Brisbane Water, separate CLAMs have been developed for seven CLAM regions within the estuary. Each of the dredging CLAM models uses a common Bayesian framework to facilitate comparison of different dredging options between the separate CLAM models. The CLAM tools have been developed as part of the *Brisbane Water Estuary Management Study* (Cardno, 2009). Much of the input data for the CLAM models was derived from the *Brisbane Water Estuary Process Study* (Cardno, 2008a).

The CLAM models have been shown to be useful in quantifying impacts and benefits of dredging options and also comparing the outcomes of different management options. The spatial complexity of Brisbane Water means there is very limited capability to use the CLAM system to investigate management options in a whole-of-estuary manner. However, the common framework applied has allowed the comparison of dredging options between the various regions.

6 Qualifications

The following qualifications and assumptions apply to this report:

- The dredging issues (and the causes to which they have been attributed) identified in this report and assessed in the Dredging CLAM have in most cases been identified by members of the community. Unless expressly indicated otherwise, these issues do not represent the professional opinion of the study team or of Council.
- The currency of data used to populate the CLAM tool is detailed in the summary sheets within the CLAM.
- The CLAM tool may only be updated, re-populated with data or re-configured by a qualified CLAM developer under the review of ANU.

7 References

ANZECC and ARMCANZ (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, pp. 317.

Cardno Lawson Treloar (2007b) *Brisbane Water Entrance Proposed SEPP35 Dredging – Coastal Processes Investigations.* Report Prepared for Gosford City Council and Department of Lands (NSW).

Cardno (2008a) *Brisbane Water Estuary Processes Study.* Prepared for Gosford City Council and Department of Environment and Climate Change.

Cardno Lawson Treloar (2008b) *Brisbane Water Dredging Option CLAMs – Summary Report.* Report Prepared for Gosford City Council and Department of Environment and Climate Change.

Cardno (2009) *Brisbane Water Estuary Management Study* (Draft). Prepared for Gosford City Council.

Patterson Britton & Partners (1999) *Environmental Impact Statement. Gosford CBD – Circular Quay Super Shuttle Ferry Service and Gosford Boat Harbour Marina & Tourist Development.*

Taylor Cullity Lethlean (2006) *Gosford Waterfront Strategy.* Prepared for the NSW Department of Planning and Gosford City Council.

WBM (2004) *Lake Macquarie Organic Sediments: Feasibility Study on Sediment Removal –Final*. Prepared for Office of Lake Macquarie Catchment.

Appendix 1

CLAM Node Descriptions

TP

INTRODUCTION

Node:

TP Concentration (local water)

Descriptions and Units:

TP concentration (mg/L) during to dredging operations. Considers existing TP conditions and additional phosphorous delivered to the water column during dredging. Within the CLAM, only water quality outcomes not water quality inputs are considered.

Input links:

- Scenario Dredging Options

Output states:

- <0.01 mg/L ,
- 0.01-0.04.mg/L ,
- >0.04mg/L ,

INITIAL RESULTS:

Method(s) Data interpretation (existing WQ)

Sample: Brisbane Water Water Quality Database
Location: Booker Bay
Collection regime: Results from Laxton (2000)
Source: Laxton (2000), Summarised in WBM (2003)
Analysis description: TP samples at Booker Bay between 1996 and 1999 (closest site to Hardy's Bay). Sample size = 82. Max = 0.09mg/L, Min = 0.005mg/L, Mean = 0.03mg/L, Median = 0.02mg/L. Nutrient concentrations within Hardy's Bay are expected to be similar to Booker Bay. The measured phosphorous concentrations are generally below ANZECC guidelines and adverse water quality outcomes are not commonly observed.
Completed by: Sean Garber
Date of completion: 24th July, 2009

Method(s) Data interpretation (dredging WQ)

Sample: Nutrient release from Dredged Sediments
Location: Proposed Gosford Boat Harbour (Broadwater)

Collection regime: Elutriate testing of sediment samples from Patterson Britton and Partners (1999)
Source: Patterson Britton and Partners (1999)
Analysis description: Elutriate testing of 3 sediment samples from the Gosford seabed indicated that the sediments in that area had the potential to release similar concentrations of soluble phosphorous and nitrogen compared to the undisturbed concentration in the water column (i.e. 0.05mg/L)
Completed by: Sean Garber
Date of completion: 24th July, 2009

Method(s) Data interpretation (Change in TP due to dredging)

Sample: Dispersion assessment near the dredging site
Location: Dredging Option Areas within Hardy's Bay
Collection regime: Based on results from a calibrated Delft3D transport dispersion model of Brisbane Water of nutrient release during dredging
Source: Estuary Management Study (ongoing) & Cardno Lawson Treloar (2007)
Analysis description: Transport / dispersion modeling indicated that dredging could lead to the following increases in average nutrient concentrations (TP) during dredging:

- Hardy's Bay Marinas - 15%
- Riley's Bay Entrance - 10%
- Mudflat Creek Entrance - 15%
- RSL Creek - 13%
- Hardy's Bay Entrance - 5%

Completed by: Sean Garber
Date of completion: 27th July, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:
* Measured TP at Booker Bay is similar to conditions within Hardy's Bay.
* Nutrient release from disturbed sediment estimated from only 3 elutriate samples

Strengths, Weaknesses and methods for improvement:
*The current modeling approach does consider the ecological response to changes in TP.
*For elutriate testing the water volume relative to the disturbed sediment area is much smaller than for a real dredging scenario. Therefore the nutrient release during dredging on a mass basis may be overestimated.

REFERENCES

Cardno Lawson Treloar (2007) Brisbane Water Estuary Processes Study – Hydraulic Processes. Prepared for Gosford Council and DECC

Paterson Britton and Partners (1999) EIS for SuperShuttle Ferry Service and Gosford Boat Harbour Marina and Tourist Development. Prepared for Supershuttle.

WBM (2003). Gosford City Council - Historical Water Quality Data Review and Analysis. Prepared for Gosford Council.

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Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
Date of completion: 6th October, 2009

TN

INTRODUCTION

Node:

TN Concentration (local water)

Descriptions and Units:

TN concentration (mg/L) during to dredging operations. Considers existing TN conditions and additional nitrogen released into the water column during dredging. Within the CLAM, only water quality outcomes not water quality inputs are considered.

- Scenario Dredging Options

Output states:

- <0.16 mg/L ,
- 0.16-0.66.mg/L ,
- >0.66mg/L ,

INITIAL RESULTS:

Method(s) Data interpretation (existing WQ)

Sample: Brisbane Water Quality Database
Location: Brisbane Water Entrance
Collection regime: Results from Laxton (2000) and Cheng (2002)
Source: Laxton (2000), Cheng (2002), Summarised in WBM (2003)
Analysis description: TN samples at Booker Bay between 1996 and 2002 (closest site to Hardy's Bay). Sample size = 113. Max = 2.6mg/L, Min = 0.04mg/L, Mean = 0.45mg/L, Median = 0.30mg/L. Nutrient concentrations within Hardy's Bay are expected to be similar to Booker Bay. The measured nitrogen concentrations are generally above ANZECC guidelines however adverse water quality outcomes are not commonly observed.
Completed by: Sean Garber
Date of completion: 24th July, 2009

Method(s) Data interpretation (dredging WQ)

Sample: Nutrient release from Dredged Sediments
Location: Proposed Gosford Boat Harbour (Broadwater)
Collection regime: Elutriate testing of sediment samples from Patterson Britton and Partners (1999)
Source: Patterson Britton and Partners (1999)
Analysis description: Elutriate testing of 3 sediment samples from the Gosford seabed indicated that the sediments in that area had the potential to release similar concentrations of soluble phosphorous and nitrogen compared to the undisturbed concentration in the water column (i.e. 1.96mg/L)
Completed by: Sean Garber
Date of completion: 24th July, 2009

Method(s) Data interpretation (Change in TP due to dredging)

Sample: Dispersion assessment near the dredging site
Location: Dredging Option Areas within Hardy's Bay
Collection regime: Based on results from a calibrated Delft3D transport dispersion model of Brisbane Water of nutrient release during dredging
Source: Estuary Management Study (ongoing) & Cardno Lawson Treloar (2007)
Analysis description: Transport / dispersion modeling indicated that dredging could lead to the following increases in average nutrient concentrations (TN) during dredging:

- Hardy's Bay Marinas - 30%
- Riley's Bay Entrance - 20%
- Mudflat Creek Entrance - 30%
- RSL Creek - 25%
- Hardy's Bay Entrance - 10%

Completed by: Sean Garber
Date of completion: 27th July, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:
* Measured TN at data is over 5-years old.
* Nutrient release from disturbed sediment estimated from only 3 samples of organic content.

Strengths, Weaknesses and methods for improvement:
*The current modeling approach does consider the ecological response to changes in TN.

REFERENCES

Cardno Lawson Treloar (2007a). "Brisbane Water Entrance Proposed SEPP35 Dredging – Coastal Processes Investigations". Prepared for Gosford Coucil and Department of Lands, Draft Report September 2007. LJ2658/R2406.

Cardno Lawson Treloar (2007b) Brisbane Water Estuary Processes Study – Hydraulic Processes. Prepared for Gosford Council and DECC

Cheng (2002) "Water Quality Monitoring of Brisbane Water and Gosford Lagoons – Summary of Data August 1999 – June 2002. Prepared for Gosford Council.

WBM (2003). Gosford City Council - Historical Water Quality Data Review and Analysis. Prepared for Gosford Council.

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
*Date of completion: 6*th October, 2009

TSS

INTRODUCTION

Node:

Total Suspended Solids (local water)

Descriptions and Units:

Total Suspended Solids concentration (mg/L) during to dredging operations. Considers existing TSS conditions and additional solids suspended into the water column during dredging.

Input links:

- Scenario Dredging Options

Output states:

- <2 mg/L ,
- 2-11 mg/L ,
- >11 mg/L ,

INITIAL RESULTS:

Method(s) Data interpretation (existing WQ)

Sample: Brisbane Water Quality Database
Location: Woy Woy and Cockle Bays
Collection regime: Results from Cheng (2002)
Source: Cheng (2002), Summarised in WBM (2003)
Analysis description: TSS samples at Woy Woy and Cockle Bays (considered similarly sheltered locations with Creek inflows) between 1993 and 1994. Sample size = 22. Max = 4.6NTU, Min = 0.6 NTU, Mean = 1.69 NTU, Median = 1.40 NTU. The suspended solids and light penetration in this area of Brisbane Water is generally above ANZECC guidelines and adverse water quality outcomes are not commonly observed. A ratio of 1NTU = 1.4mg/L has been adopted to convert from mass units to NTU (see below).
Completed by: Sean Garber
Date of completion: 25th July, 2009

Method(s) Data interpretation (dredging WQ)

Sample: NTU – mg/L relationship (Brisbane Water)
Location: Brisbane Water
Collection regime: Unknown
Source: GHD (1998)
Analysis description: It is reported that 3.6-4.5 NTU corresponds to total suspended solids of 5-6 mg/L.
Completed by: David Taylor
Date of completion: 14th June, 2007

Method(s) Data interpretation (Change in TSS due to dredging)

Sample: TSS assessment near the dredging sites
Location: Dredging Option Areas within Hardy's Bay
Collection regime: Based on results from a calibrated Delft3D model of Brisbane Water of dredge plume during dredging
Source: Estuary Management Study (ongoing) & Cardno Lawson Treloar (2007)
Analysis description: Transport / dispersion modeling indicated that dredging could lead to the following increases in average near-bed suspended sediment concentrations (TSS) during dredging:

- Hardy's Bay Marinas - 15-20mg/L
- Riley's Bay Entrance - 10-15mg/L
- Mudflat Creek Entrance - 15-20mg/L
- RSL Creek - 10-15mg/L
- Hardy's Bay Entrance - 5mg/L

A 10% near-bed re-suspension rate has been assumed. This value is typical of modern cutter-suction or auger type dredging.
Completed by: Sean Garber
Date of completion: 25th July, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:
* Background TSS concentrations assumed to be similar to sites of similar exposure and creek flows within Brisbane Water. Measured TSS from Woy Woy Bay and Cockle Bay used in the assessment.
* The rate of sediment re-suspension is highly dependant on the dredging method and competency of dredge operator

Strengths, Weaknesses and methods for improvement:
*The current modeling approach does consider the ecological response to changes in TSS.

REFERENCES

Cardno Lawson Treloar (2007) Brisbane Water Estuary Processes Study – Hydraulic Processes. Prepared for Gosford Council and DECC

Cheng (2002) "Water Quality Monitoring of Brisbane Water and Gosford Lagoons – Summary of Data August 1999 – June 2002. Prepared for Gosford Council.

WBM (2003). Gosford City Council - Historical Water Quality Data Review and Analysis. Prepared for Gosford Council.

GHD (1998) "Ettalong Beach to Sydney Fast Ferry Service – Environmental Impact Statement". Prepared by GHD for Fast Ships Pty Limited.

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
Date of completion: 6th October, 2009

TSS

INTRODUCTION

Node:

Acid Sulfate Soil

Descriptions and Units:

Assessment of potential impacts from dredging potential acid sulfate soil material.

Input links:

- Scenario Dredging Options

Output states:

- Little to none,
- Moderate,
- High,

INITIAL RESULTS:

Method(s) Data interpretation (existing WQ)

Sample: Brisbane Water Estuary Processes Study – Acid Sulfate Soils Assessment
Location: Hardy's Bay
Collection regime: Data compilation and Collection (2003-2007)

Source: GHD (2004)
Analysis description: Three sediment samples were taken within Hardy's Bay which indicate the presence of potential acid sulfate soils. The Hardy's Bay area is therefore considered a high risk for impacts on the entrance water quality and ecology.
Completed by: Sean Garber
Date of completion: 20th July, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:
* Potential Impact of PASS based on plan area of dredging option and locality within Hardy's Bay,
* PASS only becomes an issue when dredging occurs,
* average of PASS probs taken for individual dredging scenarios when considering overall PASS,
* Best practice dredging operations will be employed (as required by environmental permitting) therefore no risk to regional WQ is expected from dredging activities,
* Sediments to be dredged in Hardys Bay Entrance and Rileys Bay channel are more sandy and less likely to contain ASS.

Strengths, Weaknesses and methods for improvement:
*.

REFERENCES

Cardno Lawson Treloar (2007) Brisbane Water Estuary Processes Study. Draft report. Prepared for Gosford Council and DECC

GHD (2004) Brisbane Water Estuary Processes Study – Acid Sulphate Soils Investigations. Prepared for Cardno Lawson Treloar.

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
6th October, 2009

Seagrass Habitat Impacts

INTRODUCTION

Node:

Seagrass Habitat Impacts

Descriptions and Units:

Habitat loss due to dredging

Input links:

- Scenario Dredging Options

Output states:

- <1000 m^2 ,
- 1000 - 3000m^2 ,
- 3000 - 5000m^2 ,
- >5000 m^2

INITIAL RESULTS:

Method(s) Data interpretation

Sample: Aquatic Habitat Mapping
Location: Brisbane Water
Collection regime: Fisheries GIS layer
Source: Fisheries (NSW), obtained from GCC 2004.
Analysis description: Assessment made of the intersection between habitat areas and dredging footprints. The following impacts have been applied to each scenario:

- Hardy's Bay Marina: 1,100m^2 of Posidonia Australis habitat.
- Riley's Bay Entrance: 2,250m^2 of Posidonia Australis habitat.
- Mudflat Creek Entrance: 920m^2 of Posidonia Australis habitat.
- RSL Creek Entrance: 710m^2 of Posidonia Australis habitat.
- Hardy's Bay Entrance: No significant seagrass area.

Completed by: Sean Garber
Date of completion: 20th July, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:

Strengths, Weaknesses and methods for improvement:
*Based on the Fisheries (NSW) seagrass mapping which may not reflect the present condition.
* Indirect impacts not assessed.

REFERENCES

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
Date: 20th July, 2009

Capital Dredging

INTRODUCTION

Node:

Capital Dredging Requirement

Descriptions and Units:

Capital Dredging Requirement (one off)

Input links:

- Scenario Dredging Options

Output states:

- 0
- > 0-20,000m^3,
- 20,000-40,000m^3,

- 40,000-60,000m^3,
- > 6000m^3.

INITIAL RESULTS:

Method(s) Data interpretation

Sample: Capital Dredge Volumes
Location: Brisbane Water
Collection regime: Bathymetric Data
Source: Navigation Charts, NSW Maritime Seabed Data.
Analysis description: Calculation of required dredge volume based on assumed dredged extent and desired depth of -2mISLW.
Completed by: Sean Garber
Date of completion: 29th September, 2009

Method(s) Data interpretation (dredging cost)

Sample: Dredging cost
Location: Hardy's Bay Dredging Options
Collection regime: Analysis of report on dredging similar material at Lake Macquarie
Source: WBM (2004)
Analysis description: The feasibility study prepared by WBM for dredging organic sediments at Lake Macquarie included costing for the setup of equipment, removal and treatment of organic sediments from nearshore areas of Lake Macquarie. The initial setup cost has been estimated at $30,000 per campaign (for 15,000m^3 dredge, approx.). Dredging and treatment costs including treating acid sulfate soil is $20.1 per m^3. Dredging of clean sediments assumed to be $10 per m^3.
Completed by: Sean Garber
Date of completion: 29th September, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:

- The cost may vary due to site specific factors

REFERENCES

WBM (2004). "Lake Macquarie Organic Sediments: Feasibility Study on Sediment Removal –Final" Prepared for Office of Lake Macquarie Catchment.

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
Date: 29th September, 2009

Maintenance Dredging

INTRODUCTION

Node:

Maintenance Dredging Requirement

Descriptions and Units:

Maintenance Dredging Requirements (per year)

Input links:

- Scenario Dredging Options

Output states:

- 0
- >0-1000m^3,
- 1000-2000m^3,
- > 2000m^3.

INITIAL RESULTS:

Method(s) Data interpretation (existing siltation from catchment)

Sample: Modeling of Brisbane Water Catchment Area
Location: Hardy's Bay – Mudflat Creek
Collection regime: Based on results from MUSIC model and Delft3D transport dispersion model of Brisbane Water
Source: Cardno Lawson Treloar (2007)
Analysis description: Modelling of suspended sediment inflows from the Mudflat Creek catchment and estimation of siltation rates over the mudflat fan area. Siltation volumes from the catchment were assessed over three annual conditions (wet, average

and dry rainfall conditions) resulting in siltation volumes of 266m3 (wet), 68m3 (avg) and 44m3 (dry).
Completed by: Sean Garber
Date of completion: 24th July, 2009

Method(s) Data interpretation (siltation post dredging)

Sample: Suspended Sediment assessment of Hardy's Bay dredging areas
Location: Hardy's Bay
Collection regime: Based on results from Delft3D transport dispersion model of Brisbane Water
Source: Estuary Management Study (ongoing) & Cardno Lawson Treloar (2007)
Analysis description: Modeling of wave induced siltation rates within proposed dredged areas in Hardy's Bay. The following annual siltation rates were estimated from the modeling output:
Hardy's Bay Marina – 1.5cm/yr
Riley's Bay Channel – 2cm/yr
Mudflat Creek Entrance – 1.5cm/yr
RSL Creek Entrance – 1cm/yr
Hardy's Bay Entrance - variable
Completed by: Sean Garber
Date of completion: 24th July, 2009

Method(s) Data interpretation (dredging cost)

Sample: Dredging cost
Location: Hardy's Bay Dredging Options
Collection regime: Analysis of report on dredging similar material at Lake Macquarie
Source: WBM (2004)
Analysis description: The feasibility study prepared by WBM for dredging organic sediments at Lake Macquarie included costing for the setup of equipment, removal and treatment of organic sediments from nearshore areas of Lake Macquarie. The initial setup cost has been estimated at $30,000 per campaign (for 15,000m^3 dredge, approx.). Dredging and treatment costs including treating acid sulfate soil is $20.1 per m^3. Dredging of clean sediments assumed to be $10 per m^3. Costs are based on 5-year intervals between maintenance dredging campaigns.
Completed by: Sean Garber
Date of completion: 29th September, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:

- The cost may vary due to site specific factors
- 5-years between maintenance dredging campaigns
- The base case (no dredging at any site) has been specified as having no maintenance dredging and hence no on-going cost.

REFERENCES

WBM (2004). "Lake Macquarie Organic Sediments: Feasibility Study on Sediment Removal –Final" Prepared for Office of Lake Macquarie Catchment.

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
Date: 29th September, 2009

Other Aquatic Recreation

INTRODUCTION

Node:

Other Aquatic Recreation

Descriptions and Units:

Impacts on other Aquatic Recreation

Input links:

- Scenario Dredging Options

Output states:

- Negative,
- No Change,
- Positive,

INITIAL RESULTS:

Method(s) Data interpretation (qualitative)

Sample: Estuary Management Study Consultation
Location: Gosford City Council
Collection regime: Community Consultation
Source: Undertaken May, 2009
Analysis description: No specific aquatic recreational activity was identified within the consultation although it is assumed the maintenance on navigable depths would have a positive influence on aquatic recreation. Providing boat access to mudflat and RSL creeks may provide further recreational opportunity. Increased access and use of the Marinas could potentially have a negative influence on some activities (e.g. fishing).
Completed by: Sean Garber
Date of completion: 29th July, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:
* Maintenance of navigable depths has a positive influence on aquatic recreation.

Strengths, Weaknesses and methods for improvement:
* Arbitrary nature of the assessment.

REFERENCES

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
Date: 29th July, 2009

Boating Safety

INTRODUCTION

Node:

Boating Safety

Descriptions and Units:

Impacts on Boating Safety in Brisbane Water

Input links:

- Scenario Dredging Options

Output states:

- Decreased Safety ,
- No Change ,
- Increased Safety ,

INITIAL RESULTS:

Method(s) Qualitative assessment

Sample: Estuary Management Study Consultation
Location: Gosford City Council
Collection regime: Community Consultation
Source: Undertaken May, 2009.
Analysis description: Dredging options would control the sedimentation within Hardy's Bay and in doing so maintain design navigable depths thereby increasing boating safety. Dredging of the marina areas and the Riley's Bay entrance channel would have the most direct positive influence on boating safety.
Completed by: Sean Garber
Date of completion: 29th July, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:

Strengths, Weaknesses and methods for improvement:
* Arbitrary nature of the assessment.

REFERENCES

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
Date: 29th July, 2009

Boat Moorings and Berths

INTRODUCTION

Node:

Boat Moorings and Berths

Descriptions and Units:

Changes in number of boat moorings and berths

Input links:

- Scenario Dredging Options

Output states:

- No Change ,
- Increase < 50 berths ,
- Increase > 50 berths ,

INITIAL RESULTS:

Method(s) Data interpretation (qualitative)

Sample: CLAM Consultation
Location: Gosford City Council
Collection regime: Stakeholder input
Source: Undertaken May, 2007.
Analysis description: Boat users and NSW Maritime indicated that improving navigation at within Brisbane Water would increase the attractiveness of Brisbane Water as a boating destination and potentially increase boat moorings in Brisbane Water. For this assessment boat moorings within Riley's Bay have also been included.
Completed by: David Taylor
Date of completion: 30th October, 2007

Method(s) Data interpretation (qualitative)

Sample: Economic Impacts
Location: Central Coast Region
Collection regime: Data analysis

Source: NSW Regional Tourism Forum - 2002
Analysis description:
Completed by: David Taylor
Date of completion: 30th October, 2007

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:

Strengths, Weaknesses and methods for improvement:
* Arbitrary nature of the assessment.

REFERENCES

Tourism Revenue Data - NSW Regional Tourism Forum – 2002

****

Input updated by: David Taylor
Affiliation: Cardno Lawson Treloar
Date: 30th October, 2007

ANZECC Compliance

INTRODUCTION

Node:

Change in ANZECC Compliance due to Dredging

Descriptions and Units:

Assessment of change in ANZECC water quality guideline compliance.

Input links:

- TP,
- TN.

Output states:

- Increase ,
- No Change ,
- Decrease ,

INITIAL RESULTS:

Method(s) Data interpretation (existing WQ)

Sample: Brisbane Water Quality Database
Location: Booker Bay
Collection regime: Results from Cheng (2002) and Laxton (2000)
Source: Cheng (2002), Laxton (2000), Summarised in WBM (2003)
Analysis description: Comparing TN and TP to appropriate standards in ANZECC 2000 indicate that TN generally exceed guidelines. The median measured TP is 0.02mg/L (mean 0.03mg/L) compared to the ANZECC guideline of 0.03mg/L. Median measured TN is 0.30mg/L (mean 0.43mg/L) compared to ANZECC guideline of 0.3mg/L. Adverse water quality outcomes are not generally observed.
Completed by: Sean Garber
Date of completion: 24th July, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:
*

Strengths, Weaknesses and methods for improvement:
*.

REFERENCES

Cheng (2002) "Water Quality Monitoring of Brisbane Water and Gosford Lagoons – Summary of Data August 1999 – June 2002. Prepared for Gosford Council.

WBM (2003). Gosford City Council - Historical Water Quality Data Review and Analysis. Prepared for Gosford Council.

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
Date: 5th October, 2009

Impact on Aquatic Fauna

INTRODUCTION

Node:

Potential impact on Aquatic Fauna due to dredging

Descriptions and Units:

Fauna impact has been based on the relative amount of seagrass area impacted by the dredging. The fauna impact is represented as a percentage estimate of biomass loss due to the dredging options. The potential impact on aquatic fauna due to changes in TSS, TN and TP caused by dredging have also been considered. However, the impacts caused by changes to these variables on the aquatic biomass is likely to be minimal compared to the impacts caused by the direct loss of aquatic habitat. Therefore the CLAM model only explicitly includes the loss of aquatic habitat in the fauna biomass loss estimate.

Input links:

- Seagrass Habitat Impacts,

Output states:

- < 1% decrease
- 1-5% decrease
- 5-10 decrease
- > 10% decrease

INITIAL RESULTS:

Method(s) Data interpretation

Sample: Aquatic Habitat Mapping
Location: Brisbane Water
Collection regime: Fisheries GIS layer
Source: Fisheries (NSW), obtained from GCC 2004.

Analysis description: Assessment made of the intersection between habitat areas and dredging footprint.
Completed by: Sean Garber
Date of completion: 20th July, 2009

REVIEW OF RESULTS

INPUT LINK(S):

In Progress

REVIEW OF PROCESS:

Key assumptions:
*

Strengths, Weaknesses and methods for improvement:
*.

REFERENCES

****

Input updated by: Sean Garber
Affiliation: Cardno Lawson Treloar
Date: 20th July, 2009

Cardno LawsonTreloar

Shaping the Future

Brisbane Water Estuary Management Study

Processes CLAMs Summary Report

LJ2712/R2599

Prepared for Gosford City Council*

16 October 2009

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Report No:_____

[Currently pending review by ANU and Council. To be included in the next version of the Brisbane Water Estuary Management Study.]

Document Control

Version	Status	Date	Author		Reviewer	
1	Draft	16 October 2009	Sean Garber	SJG		

*Gosford City Council has prepared this document with financial assistance from the NSW Government through the Department of Environment, Climate Change and Water. This document does not necessarily represent the opinions of the NSW Government or the Department of Environment, Climate Change and Water.

Appendix H

Sediment Management Plan

Cardno LawsonTreloar
Shaping the Future

Brisbane Water Management Study

Sediment Management Plan

DRAFT

LJ2717/R2597

Prepared for Gosford City Council*

October 2009

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Cover Photograph: Brisbane Water entrance navigation channel near Little Box Head looking south-east towards Box Head (30 June 2008).

Document Control

Version	Status	Date	Author		Reviewer	
1	Draft	October 2009	Shani Archer	SCA	Louise Collier	LCC

*Gosford City Council has prepared this document with financial assistance from the NSW Government through the Department of Environment, Climate Change and Water. This document does not necessarily represent the opinions of the NSW Government or the Department of Environment, Climate Change and Water.

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1 Introduction

This Sediment Management Plan (SMP) aims to provide a framework for the implementation of sediment management, primarily in the form of maintenance dredging works for navigational purposes within the Brisbane Water Estuary. The Plan incorporates a summary of dredging processes.

1.1 Site Description

Brisbane Water estuary is a large estuarine water-body within the Gosford Local Government Area and is a northern tidal arm of Broken Bay. The estuary is subject to tidal exchange with the Bay, the Hawkesbury River and the Pacific Ocean. The estuary's catchment includes the major areas of Gosford to the north and Woy Woy, Ettalong, and Umina to the south. Smaller urban catchments (e.g. Pretty Beach, Green Point, Saratoga, Davistown, Empire Bay and Hardy's Bay) also discharge stormwater run-off from the eastern foreshore of Brisbane Water estuary. The two major creek systems feeding the estuary are Narara Creek and Erina Creek. The entrance of the estuary is situated between Box Head (Bouddi National Park) and Ettalong/Ocean Beach, and is partially filled with the sand of the Ettalong Point Shoal.

1.2 Overview of Sediment in the Estuary

Sediment within the Brisbane Water estuary is comprised of three general types:

- Marine origin (generally coarse, sandy material);
- Estuarine origin (generally fine, muddy material); and
- Fluvial origin (combination of coarse and fine sediment).

Of the three aforementioned sediment types, marine and fluvial sediments are most commonly dredged.

Reclamation and anecdotal reports of disposal of sediment into the estuary associated with terrestrial works or placement of dredge spoil represent a separate source of sediments.

Sediments tend to become progressively more contaminated the closer they are to urban areas, as urban inputs affect sediment quality. Marine sediments usually have higher sediment quality, whereas estuarine and fluvial sediments often have lower sediment quality due to higher contamination levels.

In certain locations, the periodic mobilisation and deposition of sediment into the Brisbane Water estuary has taken place and is expected to continue into the future. Sedimentation in the estuary may lead to:

- The impairment of navigational channels, leading to the restriction of maritime-based operations, employment and recreation;
- Health and safety issues for on-water activities;
- Reduction in water quality in upstream and semi-enclosed areas due to impaired tidal flushing; and
- Potential impacts on biodiversity due to reduced recruitment.

1.3 Relevant Studies

This SMP has been prepared to form a sub-plan of the *Brisbane Water Estuary Management Study* (Cardno, 2009a) and to be consistent with the *Brisbane Water Navigation Channel Proposed Maintenance Dredging Review of Environmental Factors* (Cardno, 2009b)

2 Sediment Issues and Options

2.1 Sediment Accretion Issues

Through the community consultation stage of the *Brisbane Water Estuary Management Study* (Cardno, 2009a), the local community identified a general requirement for maintenance dredging in several areas within the Brisbane Water estuary where residents had anecdotal reports of sediment deposition or accumulation (e.g. a location where a vessel had previously had access, was now restricted). A number of issues were raised by the community in relation to sedimentation and dredging, primarily for navigational purposes. These are listed in **Table 2.1.** In this Table, "Zone" refers to the Brisbane Water Estuary Management Zones outlined by Cardno (2009a). The location of the sediment management issues are presented in **Figure 2.1**.

2.2 Sediment Management Options

A number of the management options identified by Cardno (2009a) relate to dredging works. These management options are provided in **Table 2.2** and correspond to the dredging issues presented in **Table 2.1**. In **Table 2.1**, "Corresponding Option ID" refers to the identification numbers of corresponding management options listed in the Estuary Management Study (Cardno, 2009a). Sediment management options (scenarios) have been evaluated by (Cardno, 2009a) using the Coastal Lake Assessment and Management (CLAM) tool. Results are included in the *Estuary Management Study* (Cardno 2009a).

This Sediment Management Plan does not relate to catchment source control options. Reference should be made to the *Brisbane Water Estuary Management Study* (Cardno, 2009a) for further details of these options.

Table 2.1: Sediment Issues and Corresponding Option Numbers

Issue Number	Management Issues Identified by the Community/Council	Location	Zone	Corresponding Option ID
1	Sediment build-up at existing boat ramps prevents boat access for all vessels other than dinghies at Saratoga, Green Point and Davistown (opposite Kincumber Convent).	Saratoga, Green Point and Davistown	2	W25, W116
4	Sediment build-up, algae/weed build up (rotting smell) and pollution preventing boating access and causing problems regarding amenity at Victory Parade, Tascott. Issue exacerbated by stormwater discharge. Need for improved pedestrian access.	Victory Parade, Tascott	2	W36
8	Saratoga Channel: dredging option to allow it to be re-opened for navigation and help flush Saratoga inlet. Unsafe navigation due to sediment build-up. Observed reduction in the velocity of currents in major navigation channels.	Saratoga Channel	2	W25
9	Entrance to Paddy's Channel drop over: provision of safe navigation channel (dredging). No other access in and out of Brisbane Water. Seven year, gradual build-up of sediment. Observed reduction in velocity of currents.	Paddy's Channel	2	W25
10	Sediment build-up at Gosford Harbour preventing yacht access.	Gosford Harbour	2	W115
16	Unsafe navigation due to sediment build-up. Observed reduction in velocity of currents in major navigation channels.	Woy Woy Channel, near Pelican island	4	W117
27	Siltation and issues relating to boat access via channel.	Horsfield	3	W118
29A-F	Canals of St Hubert's Island in need of urgent maintenance to return to original design criteria. Also channels leading to the Island silting up.	St Hubert's Island	4	W19
40	Siltation of channel causing navigational hazard.	East of Ettalong	6	W119
46	Sailing boats with drop/fixed keel cannot access the Broadwater.	Cockle Channel	5	W116

Issue Number	Management Issues Identified by the Community/Council	Location	Zone	Corresponding Option ID
47	Medium to large sized craft (1m draught) cannot get in at half tide. Bay has filled up over the last couple of years. The ferries that previously ran here kept it open.	Cockle Bay, near entrance to Cockle Channel	5	W116
60	Bar mouths need dredging.	Western end of Cockle Channel	4	W116
72	Blockage of entrance and sediment accretion.	Rileys Bay	6	W121
75	Channel inadequate - have to wait for ferries to come in. Problem with SE swell. Impact on race days / regattas. Issue primarily over last 18 months.	South of Half Tide Rocks and west of Lobster Beach	6	W18
80	Shoaling of entrance affecting tidal exchange in the estuary? Need for dredging to encourage tourism and boating.	Downstream of Rip Bridge	6	W18
85	Safety issues for navigation, erosion and damage to moored boats. Wash also an issue for small boats.	East of Mulhall St, Wagstaffe	6	W119
86	Access to wharf difficult.	Hardy's Bay	6	W120
106	Navigation issue in entrance is increasingly bad. Used to be 2-way channel.	The Entrance to Brisbane Water	-	W18
129	Impacts of shoal propagation on navigability of waterways.	Ettalong Shoals, Paddy's Channel, N of Pelican Island, Cockle Channel, Saratoga	4, 5, 6	W18
178	Sediment accretion near boat ramps and loss of access.	Saratoga, Green Point, Davistown	2, 5	W25
197	Orana Street boat ramp only accessible at high tide.	Green Point	2	W25

Issue Number	Management Issues Identified by the Community/Council	Location	Zone	Corresponding Option ID
226	Poor access via the waterway to the Centennial Street boat ramp.	Saratoga	4	W25

Table 2.2: Management Options (Cardno, 2009a) that Correspond to Dredging Issues

Option ID	Management Goal Addressed	Strategy Outline	Location	Zone
W18	Sedimentary Processes	Dredge the navigation channel up to 50,000m3 in the Estuary entrance as a priority.	Entrance	6
W19	Sedimentary Processes	Undertake an ongoing program of maintenance to restore the drainage canals of St Hubert's Island to their original design criteria.	St Hubert's Island	4
W25	Sedimentary Processes	Dredge the Saratoga (Paddy's and Lintern) Channel(s) and around the boat ramps to permit better access.	Saratoga and Green Point	2
W36	Sedimentary Processes	Dredge built-up sand associated with the stormwater outlet between 29-33 Victory Parade, Tascott.	Tascott	2
W115	Sedimentary Processes	Dredge to improve access to the boat pump-out and other facilities in Gosford Harbour. The dredging should be sufficient to permit access over the full tidal cycle.	Gosford Harbour	2
W116	Sedimentary Processes	Dredge to improve navigation and access to boat ramps in Cockle Channel.	Davistown	5
W117	Sedimentary Processes	Dredge to improve navigation in Woy Woy Channel near Pelican Island.	Woy Woy	4
W118	Sedimentary Processes	Dredge to improve navigation in Woy Woy Bay.	Woy Woy Bay	3
W119	Sedimentary Processes	Extend dredging of the Entrance Reach further upstream past Kourung Gourung Point between Ettalong Beach and Pretty Beach with a view to improving	Entrance	6

Option ID	Management Goal Addressed	Strategy Outline	Location	Zone
		navigation.		
W120	Sedimentary Processes	Dredge to improve access to the boat pump-out and other facilities in Hardy's Bay. The dredging should be sufficient to permit access over the full tidal cycle.	Hardy's Bay	6
W121	Sedimentary Processes	Investigate options to address access and amenity issues associated with the blockage of the entrance to Riley's Bay and sediment accretion in this area.	Riley's Bay	6

Figure 2.1: Sediment Issues Locations

3 Project Tasks and Timeframe

A number of tasks need to be undertaken in order to implement and appropriately manage any dredging works carried out in the Brisbane Water estuary.

3.1 Project Tasks

A flow chart (**Figure 3.1**) has been produced to characterise the tasks associated with the options for dredging works in the Brisbane Water estuary. Further explanation of each task is given in **Section 3.2**.

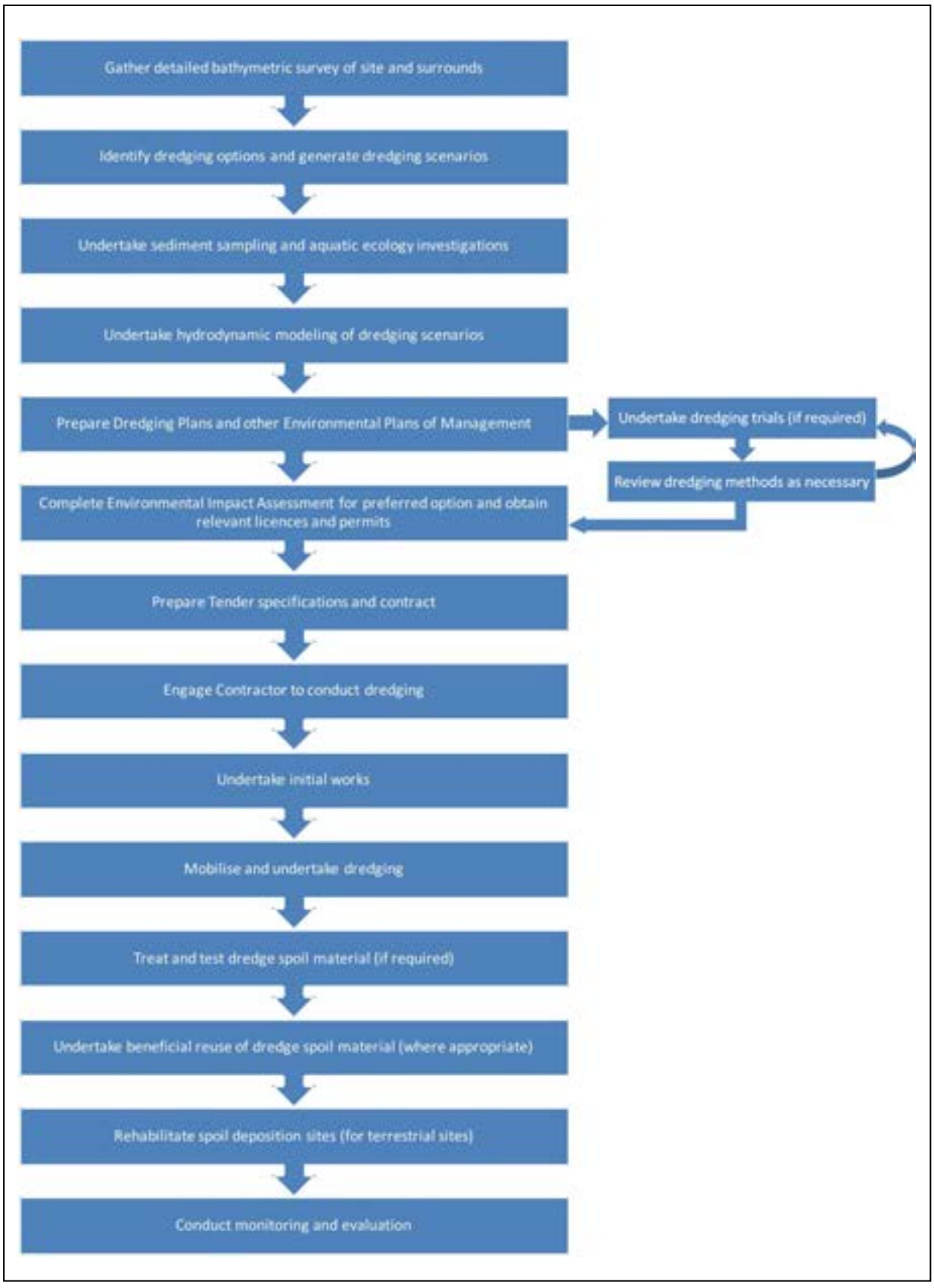

Figure 3.2: Project Tasks Flow Chart

3.2 Consideration of Project Tasks

Table 3.1 provides further detail for each of the tasks in **Figure 3.1.**

Table 3.1: Explanation of Project Tasks

Task No.	Task	Details
1	Gather detailed bathymetric survey of site and surrounds	Bathymetric data is required to characterise the current morphology of the estuary.
2	Identify dredging options and generate dredging scenarios	The depth and extent of proposed dredging should be characterised. Dredging options should be identified and dredging scenarios produced. Dredging options as identified by Cardno (2009a) are provided in **Table 2.2**.
3	Undertake sediment sampling and aquatic ecology investigations	Sampling of proposed dredge sediments should be undertaken to ascertain grain size, sediment quality and the presence of any acid sulphate soils to establish treatment and disposal/beneficial re-use options. Aquatic ecology investigations should incorporate benthic sampling and identification of presence of aquatic vegetation including any weed species.
4	Undertake hydrodynamic modeling of dredging scenarios	A hydrodynamic model should be utilised to to evaluate the impacts of dredging scenarios on the environment.
5	Prepare Dredging Plans and other Environmental Plans of Management	Dredging plans will need to be prepared, indicating areas and depths to be dredged. Environmental Plans of Management will also need to be prepared, e.g. Acid Sulfate Soils Management Plan.
5A	Undertake dredging trials (if required)	If required, relatively small-scale dredging trials should be undertaken to assess the performance of proposed dredging methods. Trials should include the treatment, testing and beneficial reuse of dredge spoil material
5B	Review dredging methods as necessary	Dredging methods may be revised according to the findings of the dredging trials. Further trials may need to be undertaken where necessary.
6	Complete Environmental Impact Assessment for preferred option and obtain relevant licences and permits	Environmental Impact Assessment (EIA) will need to be undertaken for any proposed dredging works. In order to legally carry out such works, licences and permits may be necessary under commonwealth and state legislation. This information should be incorporated into the relevant EIA documents.

Task No.	Task	Details
7	Prepare Tender specifications and contract	A Tender to invite contractors to carry out the dredging works will need to be prepared.
8	Engage Contractor to conduct dredging	Based on Tender submissions, a Contractor should be engaged to carry out the dredging works.
9	Undertake initial works	The Australian Hydrographic Service should be notified of the works so that Notices to Mariners can be updated. In addition, environmental protection measures should be installed. Dredging will occur offshore, however onshore site preparation may be necessary in cases where deposition of dredge spoils onto terrestrial areas is being carried out.
10	Mobilise and undertake dredging	Dredging works should be undertaken in accordance with the relevant EIA document and Plans of Management.
11	Treat and test dredge spoil material (if required)	Treatment of dredge material will vary according sediment type and level of contamination, etc. Dewatering of dredge spoil material is likely to be undertaken for sediments that will be deposited in terrestrial or coastal areas, and this may include the application of a polymer to aid the dewatering process. Where required, testing of representative, treated sediment samples should be conducted to determine if the dredge spoil contains contaminants such as acid sulfate soils, which would require further treatment.
12	Undertake beneficial re-use of dredge spoil material (where appropriate)	Beneficial reuse of dredge spoil material should be undertaken in accordance with the *Waste Avoidance and Resource Recovery Act 2001.* Beneficial reuse varies according to sediment type: - Sandy sediments are more suitable for deposition in nearby estuary locations, or, on beaches requiring nourishment (as appropriate). - Alluvial sediments are more suitable for deposition on nearby, terrestrial recreational reserves (as appropriate).
13	Rehabilitate spoil deposition sites (for terrestrial sites)	Areas that have received dredge spoil through beneficial reuse should be rehabilitated as required, e.g. through revegetation.
14	Conduct monitoring and evaluation	Post-dredge monitoring and reporting should be conducted as required, including a Work as Executed (WAE) survey.

3.3 Timeframe

The timeframe for the completion of dredging works will depend on the extent and volume of the works. An example of an average timeframe for dredging works is 6-12 months from design investigations to completion.

4 References

Cardno (2009a). *Brisbane Water Estuary Management Study – Draft*, Prepared for Gosford City Council.

Cardno (2009b). *Brisbane Water Navigation Channel Proposed Maintenance Dredging Review of Environmental Factors*, Prepared for Gosford City Council.

Appendix I

Management Options – Ranked by Management Category

Option ID	Management Goal Addressed	Management Category	Strategy Outline	Location	Zone	Primary Responsibility	Secondary Responsibility	Cross Reference with Option:	Dependency on Option:	Net Present Value	Potential Funding Stream	Water & Sediment Quality	Sedimentary Processes	Ecological Processes	Foreshore Flooding / Inundation	Cultural Heritage	Visual Amenity	Recreational Usage	Development	Governance	Information, Communications and Education	Raw Benefit Index	Council / DECCW Response	Community Response	Adjusted Benefit Index
C13	Foreshore Development	Compliance	Provide additional resources for enforcement of compliance with foreshore development controls.	LGA-wide	All	GCC		C02, C14		$ 794,551		2	3	3	3	1	1	0	0	0	2	15	1		16.5
C01	Water and Sediment Quality	Compliance	Establish a program of auditing to ensure best management practices for marinas around Brisbane Water Estuary. DECCW's brochure Environmental Action for Marinas, Boatsheds and Slipways should be provided to marine operators.	All marinas	All	DECCW, NSW Maritime				$ 337,820		3	2	3	0	0	1	3	0	0	2	14	0		14
C14	Foreshore Development	Compliance	Audit existing foreshore development (including property boundaries, fences and other structures, boat houses, boat ramps, jetties, etc.) and identify illegal or non-conforming development for retrospective enforcement of development controls. This should be undertaken in accordance with the Conditions of Consent and relevant policy in force at the time of Development Approval.	Estuary Foreshores	All	LPMA	GCC	C02, C13, P10, P11, P14, P44, P51, P52	R31	$ 90,000		1	3	1	2	1	1	0	0	0	2	11	1		12.5
C08	Recreational Usage	Compliance	Enforce boating regulations (particularly speed restrictions and zoning of activities) within Brisbane Water.	Waterway-wide	All	NSW Maritime		E01, E11, E12, W05, C12, C16	C09	$ 529,701		2	3	1	0	0	0	3	0	0	3	12	0		12
C02	Water and Sediment Quality	Compliance	Provide additional resources for Council officers to undertake audits of properties to ensure enforcement of policies and conditions of consent relating to water quality during both the construction and operational phases.	Catchment-wide	All	GCC		C13, P04		$ 741,581		3	3	3	0	0	0	0	0	0	0	9	2		12
C04	Habitat and Species Conservation	Compliance	Ensure ongoing enforcement of fishing regulations.	Waterway-wide	All	DII - Fisheries		E01		$ 317,820		1	0	3	0	0	0	3	0	0	3	10	1		11.5
C05	Habitat and Species Conservation	Compliance	Ensure the ongoing enforcement of Council's Tree Vandalisation Policy. Reference should also be made to D6.44 Landscape and Vegetation Management Policy.	LGA-wide	All	GCC		C06		$ 264,850		1	1	2	1	1	2	0	0	0	2	10	1		11.5
C15	Information, Communications and Education	Compliance	Enforce littering restrictions and undertake parallel education programs about littering.	LGA-wide	All	GCC		E02, E07, E11, R05, W91, W92, W93		$ 99,455	Butt Littering Trust	2	0	1	1	0	2	0	0	0	4	10	1		11.5
C07	Recreational Usage	Compliance	Ensure enforcement of the requirement to use formal dinghy storage racks provided by Council. This should include the confiscation of improperly stored dinghies or fining of the owners.	Estuary Foreshores	All	GCC		W77	P35, W86	$ 264,850		0	2	1	0	2	2	3	0	0	0	10	0		10
C03	Water and Sediment Quality	Compliance	Work with private land holders / tenants to improve stormwater management practices in the industrial estate near Hawke Street.	Kincumber	5	GCC	DECCW			$ 15,000		2	2	1	0	0	1	1	0	0	1	8	1		9.5
C10	Recreational Usage	Compliance	Enforce on-leash dog walking in restricted areas.	Catchment-wide	All	GCC				$ 317,820		-2	0	2	0	0	0	2	0	0	2	4	2		7
C06	Habitat and Species Conservation	Compliance	Investigate measures to address vandalism of regionally significant vegetation located in the reserve near Carrak Road. Measures may include the imposition of fines, education or fencing.	Kincumber	5	GCC		C05		$ 82,970		0	0	2	0	0	1	0	0	0	0	3	2		6
C16	Information, Communications and Education	Compliance	Publish statistics on infringements of boating regulations.	LGA-wide	All	NSW Maritime		C09, C08	C08	$ 79,455	Recreational Fishing Trust - Aquatic Habitat Rehabilitation Grant	0	0	1	0	0	0	0	0	2	2	5	0		5
C09	Recreational Usage	Compliance	Install solar powered speed cameras in problematic areas for enforcement of speed restrictions for boats.	Waterway-wide	All	NSW Maritime		C16	C16	$ 60,000		0	1	0	0	0	0	1	0	0	1	3	1		4.5
C12	Recreational Usage	Compliance	Investigate options for either banning or further limiting the use of jet skis in Brisbane Water Estuary.	Waterway-wide	All	NSW Maritime	GCC	C08		$ 12,500		1	1	1	0	0	0	0	-1	0	0	2	1		3.5
C11	Recreational Usage	Compliance	Prohibit all vehicular traffic along the sand on beaches (excl. vehicles used by Surf Life Savers).	Estuary Foreshores	All	GCC, SLSA				$ 5,000		1	2	1	0	0	0	-1	0	0	0	3	-1		1.5
E08	Information, Communications and Education	Education	Give consideration to methods of detecting and informing the community of changes to sea levels and other potential climate change impacts. These methods should not result in a sense of panic or alarm, instead they should empower the community to act in a well considered and informed manner and where possible, encourage the community to become engaged in Council's decision making processes. The information provided to the public should be supported by research presented by the IPCC and the State/Federal government.	LGA-wide	All	GCC	DECCW, CMA		P43	$ 25,000	National Natural Disaster Mitigation Program	1	2	0	5	0	0	0	4	0	5	17	2		20
E09	Information, Communications and Education	Education	Provide foreshore property owners with information/guidelines about what constitutes good and bad practice with respect to foreshore management (e.g. limits of mowing, stabilisation works, etc.).	Foreshore Property Owners	All	GCC	LPMA	C02, C05, C14, E10, P11, P14, P44-P50		$ 109,455		2	2	3	3	0	1	0	0	0	3	14	2		17
E07	Information, Communications and Education	Education	Establish a 'Clean Up Brisbane Water Day' with the dual objectives of removing rubbish from the Estuary foreshores and waterways, and of educating the public about the Estuary.	Waterway-wide	All	GCC	NSW Maritime, DECCW	C15, E02, E11, R05, W91, W92, W93		$ 579,701		3	2	4	0	0	2	0	0	0	4	15	1		16.5
E06	Information, Communications and Education	Education	Develop public awareness and education programs about the biodiversity of Brisbane Water, the important underlying ecological processes, and their relationships with human uses of the Estuary. The programs should focus on locations of high conservation value as a priority.	LGA-wide	All	GCC	University of Newcastle, Central Coast Marine Discovery Centre	E03, E05, E07, P20, P21, P24, P25, P38, P53, R26, R36, R39	R20, R22	$ 364,850		1	0	4	0	0	0	0	0	0	5	10	2		13
E02	Information, Communications and Education	Education	Label stormwater drain inlets in problematic areas "This drains to ……".	Catchment-wide	All	GCC		C15, E07, R05		$ 46,485		3	2	3	0	0	-1	0	0	0	4	11	1		12.5
E04	Information, Communications and Education	Education	Develop a public awareness and education program focusing specifically on the biodiversity and ecological value of saltmarsh habitats.	LGA-wide	All	GCC	CMA, DECCW	E03, E05, E06, E09, P30, P49, R19, W68, W70, W71, W76	R20, R22	N/A		1	1	4	1	0	0	0	0	0	3	10	1		11.5
E11	Information, Communications and Education	Education	Conduct an education program for the boating community on: - Their responsibilities with respect to the disposal of ballast, sewage and rubbish, - The location of existing sewage pump-out and rubbish disposal facilities, and - How to safeguard against leaks and spills, and what to do if a leak or spill occurs.	LGA-wide	All	NSW Maritime		C08, C15, E12, P02, P46, P47, R23, R34, W05	P36, P41	$ 130,940		2	0	3	0	0	0	0	0	0	3	8	2		11
E13	Information, Communications and Education	Education	Provide an education program for recreational fisherman aimed at encouraging the reporting of information via fishing surveys, gamefish tagging and the occurrence of *Caulerpa taxifolia* .	LGA-wide	All	DII - Fisheries	Fishcare Volunteers	C04, P41, R18		$ 172,425		0	0	3	0	0	0	1	1	0	2	7	2		10
E03	Information, Communications and Education	Education	Develop interpretive signage promoting the biodiversity and value of different key habitat types in the Brisbane Water Estuary, to be placed along publicly accessible foreshores. Signage should be provided at locations of high conservation value as a priority.	Publicly accessible foreshore	All	GCC		E04, E05, E08, P18-P25, P28, P53, R20-R22, R25	E06, R39	$ 311,880		0	0	4	0	0	-2	2	0	0	4	8	1		9.5
E05	Information, Communications and Education	Education	Develop a public education and awareness program about the diversity of birds and the national significance of Brisbane Water Estuary for birds.	LGA-wide	All	GCC	CMA, DECCW, local bird watching clubs	C10, E03, E06, P23, P27, R26		N/A	Australian Bird Environment Foundation Grant	0	0	4	0	0	0	0	0	0	3	7	1		8.5

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E10	Information, Communications and Education	Education	Provide information about environmentally friendly seawall options to both the community and those individuals assessing development applications for these structures. Reference should be made to DECCW's Environmentally Friendly Seawalls. A Guide to Improving the Environmental Value of Seawalls and Seawall-lined Foreshores in Estuaries.	LGA-wide	All	DECCW	GCC, LPMA	P43-P45, P48		$ 109,455		0	3	2	0	0	0	0	0	0	2	7	1		8.5
E01	Habitat and Species Conservation	Education	Distribute available NSW Maritime seagrass maps to boaters and anglers to reduce impacts on seagrass from dinghies, motors and anchors. These maps should enclose information about the community's obligations with respect to preservation of seagrasses, such as DPI's Recreational Fishing Handbooks, which contain information on marine conservation.	Registered Boat Owners	All	DII - Fisheries	CMA, Fishcare Volunteers	C08, E11, E13, P18, P21, P25, P34, R22, W658		$ 41,485		0	0	3	0	0	0	-1	0	0	3	5	2		8
E12	Information, Communications and Education	Education	Distribute NSW Maritime's 'Don't Make Waves' brochure to the boating community.	LGA-wide	All	NSW Maritime		C8		$ 79,455		1	1	2	0	0	0	0	0	0	2	6	1		7.5
P41	Recreational Usage	Planning	Prepare a Brisbane Water Estuary Users Plan which addresses such issues as equity of access, boat storage, conflicts of usage, mooring types and caps, number and type of public access points (wharves and jetties), coverage and consistency of foreshore Plans of Management with priority areas identified for new Plans of Management, estimation of an estuary carrying capacity with respect to development intensity, fishing/fisheries and boating.	Estuary Foreshores/Waterway-wide	All	GCC		C12, P37, P55, R33, W81	R31, R32	$ 60,000		2	2	5	0	0	2	5	5	0	5	26	2		29
P57	Commercial Development	Planning	Use the findings of the Brisbane Water Estuary Processes Study to inform the masterplanning process for the Gosford city centre.	Gosford	2	GCC	DoP	P56		N/A		1	1	2	2	3	3	3	3	0	3	21	2		24
P43	Foreshore Development	Planning	Prepare a Sea Level Rise Study that will deliver land use zoning and development controls for the Estuary that are based on the current IPCC projections of 0.91m sea level rise by 2100. The preparation of this study should be closely linked to the Brisbane Water Foreshore Flood Plain Risk Management Study & Plan, anticipated to be drafted by 2011.	Estuary Foreshores	All	GCC	DECCW	P10, P15, P44, P45, P51, P52, P54		$ 45,000		0	3	2	5	4	0	-1	3	0	5	21	2		24
P53	Commercial Development	Planning	Promote the Brisbane Water Estuary for eco-tourism and support relevant local commercial development in this area.	Estuary Foreshores/Waterway-wide	All	GCC	LPMA, Central Coast Tourism, Gosford Chamber of	P22, P38, P54, P55,	P54	$ 1,359,401		0	0	5	0	4	2	5	5	0	0	21	1		22.5
P54	Commercial Development	Planning	Promote the sustainable commercial development of the Estuary and its foreshores in accordance with Council's Corporate Strategy and the principles of Ecologically Sustainable Development.	Catchment-wide/Waterway-wide	All	GCC	LPMA	P53, P55, P56, P57		$ 582,671		-1	-1	4	-1	4	3	4	5	0	0	17	2		20
P04	Water and Sediment Quality	Planning	Review and revise DCP 165 - Water Cycle Management to reflect current best practice.	LGA-wide	All	GCC		C02, C13, P43, W58		$ 40,000		4	2	4	4	0	0	2	1	0	0	17	2		20
P56	Commercial Development	Planning	Develop a strategy to promote and enhance the connection between the Gosford city centre and the Brisbane Water Estuary.	Gosford	2	GCC	DoP	P57		N/A		0	0	0	0	5	3	5	3	0	2	18	1		19.5
P58	Governance	Planning	Ensure the ongoing involvement of the Coasts and Estuaries Management Committee in the implementation of the Plan. Representation from the community, Council and from all the agencies responsible for implementation of the Plan should be maintained at all times.	Catchment-wide/Waterway-wide	All	GCC	DECCW	P36-P38, W113		N/A		2	2	2	2	1	1	1	0	4	2	17	1		18.5
P59	Governance	Planning	Develop a Vision Statement for the Brisbane Water Estuary consistent with the goals and objectives of the Plan.	Catchment-wide/Waterway-wide	All	GCC		P36-P38, W114		$ 5,000		0	0	3	0	1	1	1	1	5	5	17	1		18.5
P15	Habitat and Species Conservation	Planning	Re-assess existing zoning and tenure of foreshore land with a view to providing for a range of human usages (recreational and commercial), as well as environmental protection, with due consideration of the potential impacts of climate change.	Estuary Foreshores	All	LPMA	GCC	P16, P44-P45, P48-P52, W60, W84	W34	$ 45,000		0	2	3	2	2	2	3	2	0	0	16	1		17.5
P06	Sedimentary Processes	Planning	Develop an Entrance Management Policy for Brisbane Water to provide a strategic framework for the maintenance of navigation through the Estuary entrance.	Entrance	6	GCC	NSW Maritime	R09, R27, W18, W28	P07	$ 71,485		0	5	2	0	-1	0	4	0	2	2	14	2		17
P01	Water and Sediment Quality	Planning	Provide for the development, implementation and regular re-assessment of Riparian Zone and Bank Management Plans for the major tributaries draining into the Estuary, including Narara Creek, Erina Creek, Kincumber Creek (Riparian Plan already in place), Woy Woy Creek and Ettalong Creek.	Catchment-wide	All	GCC	DWE	P13, W34, W53		$ 1,574,252		4	3	4	1	0	2	0	0	0	0	14	2		17
P60	Information, Communications and Education	Planning	Ensure that climate change considerations are incorporated into all relevant Plans of Management for locations around the Estuary.	LGA-wide	All	GCC	DECCW, CMA	E8, P42, W60	P43	$ 55,000		0	0	2	4	4	0	0	0	0	3	13	2		16
P07	Sedimentary Processes	Planning	Based on our understanding of the ecological and physical processes operating within the Estuary, develop a channel layout for recreational and commercial boating usage which details current (and potential future) channel widths and depths to provide users of Brisbane Water with certainty while acknowledging the limitations of the Estuary. The channel layout should take into consideration environmental impacts and address the natural rates of sedimentary accretion in those locations.	Waterway-wide	All	GCC, LPMA	NSW Maritime	P06, R09, W18-W20, W25		$ 142,376		0	4	3	0	0	0	4	1	2	2	16	0		16
P45	Foreshore Development	Planning	Undertake a review of the existing foreshore development policies and plans for the Gosford LGA and assess the need to amend development controls to provide for controlled, sustainable development of the foreshore.	LGA-wide	All	GCC		P08, P09, P10, P29, P30, P54 , W82	P43	$ 60,000		1	4	3	4	1	3	0	-2	0	0	14	1		15.5
P49	Foreshore Development	Planning	Develop guidelines (or compile existing guidelines where available) for foreshore stabilisation via the establishment of locally native estuarine plant species. The guidelines should provide details of the benefits of soft stabilisation works, advice on the species to be used and how to establish plantings. Seedlings may be cultivated at Council's nursery for supply to interested parties.	LGA-wide	All	GCC	CMA, DECCW	W34, W41, W42, W45, W48, W49, W104		$ 559,701		2	5	4	2	0	0	0	0	0	2	15	0		15
P50	Foreshore Development	Planning	Review D6.47 - Setback Policy: Creeks, Rivers and Lagoons. The review should in the first instance widen the definition of applicable waterbodies to incorporate 'estuaries', and in the second instance be re-assessed to incorporate the likely impacts of climate change. In particular, the setbacks applied should be re-assessed to take into account processes relating to both catchment flooding and foreshore inundation.	LGA-wide	All	GCC		P44	P43	$ 15,000		0	4	3	5	0	0	0	0	0	0	12	2		15
P25	Habitat and Species Conservation	Planning	For those areas of seagrass at Ettalong shown to be important for fish recruitment, develop a strategy to protect and conserve them, including an education program for beach users, and undertake regular monitoring to assess the condition of the seagrass.	Ettalong	6	GCC	CMA, DII - Fisheries, CCCEN	E01, P09, P18, P20, P21, R20, R23, W65		$ 362,820		1	0	5	0	0	0	2	2	0	2	12	2		15
P28	Habitat and Species Conservation	Planning	Provide adequate resources within Council to provide for ongoing management of Bushcare volunteers.	LGA-wide	All	GCC		W71, W73, W76, W78, W80		$ 847,521		1	1	5	0	0	1	1	0	0	3	12	2		15
P14	Sedimentary Processes	Planning	Continue to enforce prohibition of mowing to the waters edge in both public and private foreshore areas in order to minimise foreshore erosion and impacts on estuarine vegetation.	Green Point	2	GCC		E09, R22		$ 158,910		2	3	2	1	0	2	0	0	0	1	11	2		14

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P12	Sedimentary Processes	Planning	Develop an Emergency Action Plan for Ettalong Beach in accordance with NSW Coastal Policy. The aim of the Plan should be to establish a framework for managing storm erosion events in a strategic fashion that considers public safety, public access and amenity, and ecological concerns. This option is dependent upon information provided in a Coastal Hazard Study.	Ettalong	6	GCC	DECCW	R11, W17, W28, W29, W55, W97, W112	P42, P43	$ 130,000	NSW Coastal Management Program	0	3	0	3	0	1	3	0	0	0	10	2		13
P17	Habitat and Species Conservation	Planning	Develop an Estuary-wide strategy for the management of aquaculture.	Waterway-wide	All	DII - Fisheries	GCC	W74, W100		$ 63,307		2	0	3	0	0	1	-1	3	0	3	11	1		12.5
P16	Habitat and Species Conservation	Planning	Investigate opportunities to purchase saltmarsh areas for incorporation into Council's reserve system in accordance with policy R0.15 - Acquisition of Wetlands.	Estuary Foreshores	All	GCC	LPMA	R19		$ 5,297,007		1	1	4	2	0	0	1	0	0	0	9	2		12
P36	Recreational Usage	Planning	Review of policies relating to boating use of the Estuary with a view to providing a balance between recreational and ecological uses. The review should include an assessment of policies relating to: - Speed limits, - No wash areas, - Dinghy storage areas, - Moorings, and - Jetties.	Estuary Foreshores/Waterway-wide	All	GCC	NSW Maritime, LPMA, University of Newcastle	P08, P37, P41, P48, R31, R32		$ 35,000		2	2	2	0	0	0	3	0	0	0	9	2		12
P09	Sedimentary Processes	Planning	Implement tighter erosion and sedimentation controls to minimize risks to seagrass, with a priority for catchments adjacent to areas of seagrass of high value for species.	Catchment-wide	All	GCC	DII - Fisheries	C13, P18, P20, P21, P25, R20, W35		$ 264,850		2	3	4	0	0	0	0	0	0	0	9	2		12
P48	Foreshore Development	Planning	Develop environmentally friendly design and construction guidelines for foreshore infrastructure such as jetties, boat ramps and foreshore protection works. This should include advice on retro-fitting existing structures to be more environmentally friendly. The guidelines should be made publicly available and distributed to all foreshore property owners. (Note: Seawalls addressed in DECCW's *Environmentally Friendly Seawalls Guidelines*).	LGA-wide	All	GCC	NSW Maritime, DECCW, DII - Fisheries	R11, W29, W38		$ 93,564		2	3	3	0	0	0	0	0	0	2	10	1		11.5
P20	Habitat and Species Conservation	Planning	Develop a conservation and education strategy for seagrass beds that support the highest diversity and abundance of fish, for beds at Koolewong, Woy Woy Bay, Woy Woy Inlet, Saratoga, and Davistown.	Koolewong, Woy Woy Bay, Woy Woy Inlet, Saratoga, and Davistown	All	GCC	DII - Fisheries, University of Newcastle, Fishcare Volunteers	E01, P18, P21, P22, P25, R20, W65		$ 140,940		1	0	5	0	0	0	1	0	0	3	10	1		11.5
P38	Recreational Usage	Planning	Undertake a public consultation process for input into planning for protection of areas of the Estuary important for biodiversity, habitats and ecological processes.	LGA-wide	All	GCC	DII - Fisheries, DECCW, University of Newcastle	P17-P25, R25		$ 35,000		2	0	5	0	0	0	0	0	0	3	10	1		11.5
P31	Cultural Heritage	Planning	Provide ongoing protection for sites of significance for local Aboriginal people.	LGA-wide	All	DECCW	GCC	P29	WP28, W34	$ 476,731		0	0	0	2	5	1	0	0	0	0	8	2		11
P21	Habitat and Species Conservation	Planning	Develop a conservation and education strategy for seagrass beds known to be important for sponges and ascidians: Point Clare, Saratoga, Kincumber, Yattalunga, Pretty Beach, Wagstaff Point.	Point Clare, Saratoga, Kincumber, Yattalunga, Pretty Beach, Wagstaff Point	All	GCC	DII - Fisheries, DECCW, University of Newcastle	E01, P18, P20, P22, P25, R20, W65		$ 140,940		1	0	5	0	0	0	0	0	0	3	9	1		10.5
P02	Water and Sediment Quality	Planning	Develop and implement a pollution response strategy to address major pollution events. Policy D1.02 - Oil Spillages in Navigable Waters should be updated accordingly.	Waterway-wide	All	GCC	DECCW, NSW Maritime	C01, E11		$ 25,000	National Natural Disaster Mitigation Program	2	0	5	0	0	0	2	0	0	0	9	1		10.5
P27	Habitat and Species Conservation	Planning	Develop a Plan of Management to provide protection for the Green and Golden Bell Frog and the Bush Stone Curlew populations occurring in Davistown.	Davistown	5	GCC	University of Newcastle	E05, P23, P24		$ 55,000	Australian Bird Environment Foundation Grant	1	0	5	0	0	0	0	0	0	1	7	2		10
P42	Recreational Usage	Planning	Update the existing Ettalong Beach Plan of Management in line with the findings of the Brisbane Water Estuary Processes Study and in line with the objectives of the Estuary Management Plan.	Ettalong	6	GCC		P12, R11, W28, W29, W97		$ 60,000		0	1	1	1	1	1	1	1	1	0	8	1		9.5
P44	Foreshore Development	Planning	Develop a guiding policy regarding the water boundary determination for foreshore properties consistent with Clause 55N of the *Coastal Protection Act 1979* .	Estuary Foreshores	All	LPMA	GCC		P43	$ 20,000		1	4	0	4	0	0	-1	-2	0	0	6	2		9
P47	Foreshore Development	Planning	Enforce jetty sharing arrangements via the leasing mechanism such that each jetty services 2-3 properties. This will involve review of applications for new leases as well as license/lease renewals.	Waterway-wide	All	LPMA		P33, P46		$ 25,000		2	1	1	0	1	2	-1	0	0	0	6	2		9
P23	Habitat and Species Conservation	Planning	Develop a conservation strategy for the birds of Brisbane Water Estuary that addresses the main issues of disturbance by pedestrians, dog-walkers and watercraft, predation by feral and domestic animals and habitat loss/degradation.	Waterway-wide/Catchment-wide	All	GCC	CMA, DECCW, local bird watching clubs	E05, P24, P27		$ 135,940	Australian Bird Environment Foundation Grant	0	0	5	0	0	0	1	0	0	0	6	2		9
P24	Habitat and Species Conservation	Planning	Develop conservation and education strategies for the Bush Stone-Curlew of Brisbane Water.	Kincumber Broadwater, Woy Woy	3, 5	GCC	CMA, DECCW, local bird watching clubs	P23, P27, C10		$ 135,940	Australian Bird Environment Foundation Grant	0	0	3	0	0	0	1	0	0	2	6	2		9
P26	Habitat and Species Conservation	Planning	Re-zone ecologically sensitive portions of the Estuary waterbody W2 - Environmental Protection under Council's forthcoming LEP.	Waterway-wide	All	GCC	DoP	E05, P24		$ 15,000		3	2	4	0	0	1	-3	-3	0	2	6	2		9
P32	Visual Amenity and Landscape Character	Planning	Develop a policy for the preservation of iconic views around the Estuary and its catchment.	Waterway-wide/Catchment-wide	All	GCC		C05	R30	$ 15,000		0	0	0	0	4	5	0	0	0	0	9	0		9
P19	Habitat and Species Conservation	Planning	Develop a strategy for the conservation of areas (e.g. estuarine protected areas) important for the biodiversity of invertebrates. Particular attention should be paid to priority sites that represent the greatest proportion of species, including Ettalong, Narara Creek, Koolewong, and Woy Woy Bay-Pelican Island.	Ettalong, Narara Creek, Koolewong, and Woy Woy Bay-Pelican Island	All	GCC	DII - Fisheries, DECCW, University of Newcastle	P21, P22		$ 283,068		1	0	5	0	0	0	-2	0	0	3	7	1		8.5
P29	Habitat and Species Conservation	Planning	Develop a "Green Offsets" Policy aimed at: - Ensuring significant vegetation in the LGA is protected, - Facilitating some development that may have some negative environmental impacts, - Ameliorating the negative impacts of development at a local and regional scale, and - Providing for environmental enhancement and restoration.	LGA-wide	All	GCC		C05, C06		$ 150,000		1	1	2	0	0	1	0	2	0	0	7	1		8.5
P46	Foreshore Development	Planning	Review existing DCP 119 - Wharves and Jetties with a view to ensuring the policy is in accordance with the goals and objectives of the Estuary Management Study and Plan. In addition, sea level rise projections should also be considered where facilities are to be upgraded.	LGA-wide	All	GCC	LPMA	P45	P43	$ 12,500		0	2	2	0	0	1	0	0	0	0	5	2		8
P51	Foreshore Development	Planning	Implement development setbacks to provide for increased public access to the Estuary foreshores where new development occurs or existing sites are re-developed.	Estuary Foreshores	All	GCC		P50, P44, W82	P43	N/A		0	2	0	0	0	0	3	0	0	0	5	2		8
P22	Habitat and Species Conservation	Planning	Provide protection for those areas identified in the Estuary Processes Study as being important for biological connectivity in the Estuary.	Waterway-wide/Catchment-wide	All	GCC	DII - Fisheries, DECCW	P26, P38		$ 30,000		0	0	5	0	0	0	0	0	0	0	5	2		8

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P35	Recreational Usage	Planning	Develop a guideline for the installation of dinghy storage racks covering: - Suitable types of storage racks, and - Suitable locations for installation compatible with existing uses and ecological constraints.	Estuary Foreshores	All	GCC		C07, P36, W77	R31, W86	N/A		0	1	1	0	0	1	2	0	0	0	5	2		8
P13	Sedimentary Processes	Planning	Geomorphological assessment required to develop options to address the bank erosion occurring upstream of Ann Close Reserve on Narara Creek.	Narara	1	GCC			P01, W34	$ 45,000		1	1	1	0	0	1	1	0	0	0	5	2		8
P33	Recreational Usage	Planning	Provide linkages between different portions of publicly accessible foreshores by linking with other foot or cycle paths and public transport linkages.	Catchment-wide	All	GCC		W41, W82, W84, W94, W104, W110		$ 20,000		0	0	0	0	0	0	4	0	0	0	4	2		7
P30	Habitat and Species Conservation	Planning	Develop a DCP for Wetlands aimed at maintaining and restoring natural biological and physical processes of wetland function by minimising changes to wetland hydrology from land uses in the catchment.	LGA-wide	All	GCC		C13, P04		$ 40,000		2	1	2	0	0	1	0	-1	0	0	5	1		6.5
P11	Sedimentary Processes	Planning	Develop standard designs or guidelines for retaining walls to ensure consistent character and appearance across all locations for which they are necessary.	LGA-wide	All	GCC				$ 12,000		0	2	2	0	0	1	0	0	0	0	5	1		6.5
P10	Sedimentary Processes	Planning	Develop planning controls specific to the foreshore running between Ettalong and Booker Bay to limit activities in the active coastal zone to those compatible with the observed cycles of sediment accretion and erosion.	East of Schnapper Road, Ettalong	6	GCC	DECCW	P12, P42, P52, R11, W28, W29, W55	P35, P43, P44	$ 30,000		0	2	0	3	1	0	-1	-2	0	0	3	2		6
P39	Recreational Usage	Planning	Assess options for relocation of the Pretty Beach pool such that it will be suitable for swimming under all tidal conditions and is not subject to sediment build-up.	Pretty Beach	6	GCC		W30-32		$ 55,000		1	1	0	1	0	0	1	0	0	0	4	1		5.5
P05	Water and Sediment Quality	Planning	Investigate the need for sediment traps and other stormwater management measures to control any erosion and sedimentation from sloping lands draining to the stormwater outlet opposite Byalla Lane.	Saratoga	2	GCC			R24, W01	$ 17,500		1	1	1	0	0	0	1	0	0	0	4	1		5.5
P18	Habitat and Species Conservation	Planning	Develop a strategy to protect seagrass beds known to be important for syngnathid fishes (seahorses, pipefish).	Waterway-wide	All	GCC	DII - Fisheries	E01, P20-P22, P25, R20, W65		$ 140,940		1	0	4	0	0	0	0	0	0	0	5	0		5
P08	Sedimentary Processes	Planning	Review and revise DCP 145 Boating Facilities in St Hubert's Island Canals to ensure consistency with the goals objectives of the Management Study and Plan. In particular, explicit consideration of sedimentary processes should form part of the assessment process for all development applications.	St Hubert's Island	4	GCC		W19, W35	R13	$ 15,000		0	1	2	0	0	0	-1	0	0	0	2	2		5
P34	Recreational Usage	Planning	Investigate options for further zonation of the waterway for different water-based recreational activities, with due consideration of ecologically sensitive areas. This option would involve re-assessment of the existing boating map for Brisbane Water prepared by NSW Maritime.	Waterway-wide	All	NSW Maritime		P26 , P36, P37	P41	$ 55,000		3	0	1	0	0	0	-2	-1	0	0	1	2		4
P52	Foreshore Development	Planning	Assess the need to strengthen existing controls or develop new controls relating to foreshore development to provide for public right of way along the foreshore.	Estuary Foreshores	All	GCC		P44, P45, P52, W82	P43	$ 30,000		0	0	0	1	0	0	3	-2	0	0	2	1		3.5
P37	Recreational Usage	Planning	Provide either a speed restriction or ban on water skiing in Waterfall Bay in order to minimise conflicts between houseboats and water skiers.	Waterfall Bay	3	NSW Maritime		C08, C09, P41		$ 68,267		0	0	1	0	0	0	1	0	0	0	2	1		3.5
P40	Recreational Usage	Planning	Identify 'green' alternatives for the disposal of seaweed removed from the Estuary foreshores (e.g. use in gardening activities).	Estuary Foreshores	All	GCC	Volunteers			$ 7,500		0	0	3	0	0	0	0	0	0	0	3	0		3
P55	Commercial Development	Planning	Investigate options for constructing new (and/or expanding existing) boating facilities.	Waterway-wide	All	LPMA, Private Developers	GCC	P54	R32	$ 100,000		-2	-2	-1	0	0	-1	4	4	0	0	2	0		2
P03	Water and Sediment Quality	Planning	Investigate option of prohibiting 2-stroke outboard motors.	Waterway-wide	All	NSW Maritime	GCC			$ 10,000		2	0	2	0	0	0	-5	0	0	0	-1	0		-1
R37	Governance	Research/Monitoring	Design an Estuary Monitoring Plan to include elements of the physical, social and biological environment to evaluate the success in meeting the objectives and goals outlined in the Estuary Management Plan. The monitoring program should be designed with consideration of the unique characteristics of the Estuary and support the recommendations of the Brisbane Water Estuary Process Study. Consideration should be given to including monitoring for climate change impacts.	Catchment-wide/Waterway-wide	All	GCC		R37, R40		$ 607,671		4	4	4	3	2	1	1	0	5	5	29	2		32
R36	Governance	Research/Monitoring	Establish an annual reporting mechanism to communicate progress towards achieving the goals and objectives of the Management Plan, with specific reference to any actions or monitoring undertaken during that year, as well as the effectiveness of implementation of the Plan based on comparison with specific performance targets/indicators. The annual report should be distributed amongst Council, the CEMC and the community to ensure that all parties are informed of the Plan.	Catchment-wide/Waterway-wide	All	GCC		R40	R38	$ 158,910		3	3	3	3	2	1	1	0	5	5	26	1		27.5
R38	Governance	Research/Monitoring	Research possible sources of funding and secure ongoing funding for implementation of the Plan. It is anticipated that responsibility and funding for these studies/plans may be shared across State, Federal and local government agencies.	Catchment-wide/Waterway-wide	All	GCC		R38		N/A		2	3	3	3	3	1	1	0	5	0	21	1		22.5
R02	Water and Sediment Quality	Research/Monitoring	Ensure ongoing monitoring of the water and sediment quality of the Brisbane Water Estuary for the purposes of recreational usage and ecological health.	Waterway-wide	All	GCC	CMA	R37, R38, R40	R01	$ 2,330,683		5	0	3	0	0	0	4	1	1	3	17	2		20
R24	Habitat and Species Conservation	Research/Monitoring	Investigate the use of constructed wetlands, sediment and detention basins and other WSUD options to minimise the effect of freshwater and sediment inflows, with particular reference to areas of high biodiversity value around entrances to creeks. Consideration should be given to both current and future meteorological conditions.	Catchment-wide	All	GCC	CMA	W01		N/A		3	4	3	5	0	0	2	0	0	0	17	1		18.5
R26	Habitat and Species Conservation	Research/Monitoring	Develop a research partnership with universities to continue the scientific focus on Brisbane Water Estuary and support this with annual research grants.	LGA-wide	All	GCC	Universities	E06, P19-P21, P27, P38		$ 453,761	Australian Research Council Grants	2	2	3	1	1	0	0	2	1	5	17	1		18.5
R39	Information, Communications and Education	Research/Monitoring	Develop and maintain a database of all environmental and ecological data available for the Brisbane Water Estuary with a view to providing a comparison between present and historic Estuary conditions. This database should be regularly updated with the results of any monitoring undertaken. Long term trends should be identified and this information communicated directly to the public on a regular basis.	Catchment/Waterway-wide	All	GCC	CMA, DECCW	R38, R04		$ 152,425		3	3	3	3	0	0	0	0	0	4	16	1		17.5
R06	Water and Sediment Quality	Research/Monitoring	Undertake ongoing monitoring and maintenance of Council owned stormwater quality improvement devices.	Catchment-wide	All	GCC		R02, R04, R05		N/A		5	2	3	1	0	0	2	0	0	0	13	2		16

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R31	Recreational Usage	Research/Monitoring	Conduct an audit of existing land-based and water-based infrastructure for boating (e.g. picnic tables, playgrounds, BBQs, jetties, boat ramps, dinghy storage areas, moorings, trailer parking areas, etc.) focusing on: - Patterns in patronage/usage, - Condition and maintenance requirements, - Characterisation of neighbouring land uses, - Proximity to key habitat, heritage items and other environmentally sensitive areas, - Proximity to key locations (e.g. pump out stations, marinas, popular fishing spots, etc.), and - Safety. Based on the outcome of the audit, assess the need to upgrade, maintain or de-commission existing infrastructure.	Estuary Foreshores/Waterway-wide	All	GCC	LPMA, NSW Maritime	P34-P37, P41, P47, P55, R32, W69, W77, W81, W86, W93, W94-W96	P43	$ 120,000		1	1		1	1	1	5	2	0	0	12	2		15
R01	Water and Sediment Quality	Research/Monitoring	Conduct a review of the design and methodology employed in the existing water quality monitoring program. Ideally the program should be a comprehensive, scientifically rigorous and ongoing program of water and sediment quality monitoring for the Brisbane Water Estuary, incorporating dry weather and event monitoring of both the tributary mouths and main waterbody. Sampling in the main waterbodies should incorporate vertical profiling.	Catchment/Waterway-wide	All	GCC	CMA	R37, R38, R40		$ 35,000		4	0	3	0	0	0	3	0	0	1	11	2		14
R10	Sedimentary Processes	Research/Monitoring	Conduct a condition assessment of existing stormwater outlets draining into the Estuary focusing on assessing impacts on natural sedimentary processes (e.g. erosion, accretion) and adjacent habitats.	All foreshore areas	All	GCC		W27, W36, W51, W61-W64		$ 80,000		3	3	3	3	0	0	0	0	0	0	12	1		13.5
R11	Sedimentary Processes	Research/Monitoring	Assess options for shoreline protection works that will seek to address the long-term erosion issues at Ettalong Beach.	Ettalong Beach	6	GCC	LPMA	P12, P43, W28, W29	P42	$ 80,000	NSW Coastal Management Program	0	3	2	2	1	0	3	1	0	0	12	1		13.5
R22	Habitat and Species Conservation	Research/Monitoring	Monitor the extent and condition of riparian, foreshore and aquatic vegetation around the Brisbane Water Estuary. Trends in vegetation condition and extent should be reported annually.	Waterway-wide/Catchment-wide	All	GCC	CMA, DII - Fisheries	R20, R36, R37		$ 648,141		0	1	4	1	0	1	0	0	0	3	10	2		13
R04	Water and Sediment Quality	Research/Monitoring	Audit the performance of existing stormwater quality improvement devices and assess the need for modifications.	Catchment-wide	All	GCC		R05, R24, W01		$ 32,000		3	3	4	0	0	0	0	0	0	0	10	2		13
R09	Sedimentary Processes	Research/Monitoring	Conduct ongoing monitoring (by survey) of key navigation channels, including: - Entrance Channel, - Paddy's Channel, - Lintern Channel, - Woy Woy Channel, - Wagstaff Channel, - Cockle Channel, and - Saratoga Channel.	Waterway-wide	All	NSW Maritime		P06, P07, W18-W25		$ 79,455		0	3	0	0	-1	0	4	3	0	0	9	2		12
R33	Recreational Usage	Research/Monitoring	Survey recreational fishermen to characterise demand, target species, gear type, etc.	Waterway-wide	All	DII - Fisheries	GCC, Fishcare Volunteers	E13, R18		$ 55,000	Recreational Fishing Trust	0	0	3	0	0	0	4	3	0	0	10	1		11.5
R27	Cultural Heritage	Research/Monitoring	Identify the likely location and condition of ship wrecks near the old bar via a maritime archaeological survey.	Entrance	6	DoP	LPMA	W18		$ 80,000		0	2	0	0	5	0	1	0	0	0	8	2		11
R21	Habitat and Species Conservation	Research/Monitoring	Revise SEPP14 boundaries based on latest wetland vegetation mapping.	LGA-wide	All	DoP	DII - Fisheries			$ 35,000		0	0	5	0	0	0	0	0	0	3	8	2		11
R28	Cultural Heritage	Research/Monitoring	Assess the potential impacts of climate change on heritage items located around the Estuary and along its foreshores.	Waterway-wide/Catchment-wide	All	DoP	GCC	R28	P43	$ 50,000	NSW DoP Heritage Grant	0	0	0	3	5	1	0	0	0	0	9	1		10.5
R18	Habitat and Species Conservation	Research/Monitoring	Conduct a survey of recreational fishing catches and analyse recreational fishing trends to characterise both the impact on the fish populations of Brisbane Water Estuary and the value of recreational fishing as a local industry.	Waterway-wide	All	DII - Fisheries	University of Newcastle, Fishcare Volunteers	E13, R18, R33		$ 55,000	Recreational Fishing Trust	0	0	2	0	0	0	3	4	0	0	9	1		10.5
R03	Water and Sediment Quality	Research/Monitoring	Calculate a nutrient budget for the Estuary to assess the potential for eutrophication of the more enclosed portions of the waterway. The analysis should assess current conditions and conditions under climate change scenarios. Reference should be made to the water quality modelling undertaken for the Estuary as a whole, as outlined in Appendix E of the Brisbane Water Estuary Processes Study.	Waterway-wide	All	DECCW	GCC	W11, W12, W24	R03	$ 20,000		4	0	4	0	0	0	1	0	0	0	9	1		10.5
R14	Sedimentary Processes	Research/Monitoring	Investigate options for replacing or modifying the existing seawall along Dane and Mason Parades with an environmentally friendly seawall. The options should aim to dissipate incoming waves and address erosion occurring at this location.	Gosford	2	GCC		E10, P48, W69		$ 60,000	NSW Coastal Management Program	1	2	2	1	0	1	1	0	0	0	8	1		9.5
R19	Habitat and Species Conservation	Research/Monitoring	Investigate options for the landward migration of intertidal habitats such as saltmarsh under climate change scenarios.	Estuary Foreshores	All	GCC	CMA, DECCW	E8, P42, W60	P43	$ 60,000		0	2	3	3	0	0	-2	0	0	0	6	2		9
R13	Sedimentary Processes	Research/Monitoring	Audit foreshore structures such as boat ramps, seawalls and the like, in the canals of St Hubert's Island and identify those structures that are exacerbating erosion or accretion issues for other properties. Where feasible, require license holders for these structures to modify or retrofit problematic structures to mitigate these issues. Where possible, promote reinstatement of a natural vegetated shoreline. This may be achieved through the licensing/license renewal process.	St Hubert's Island	5	GCC	LPMA	C14, R31		$ 60,000		1	2	3	0	0	0	0	0	0	0	6	2		9
R30	Visual Amenity and Landscape Character	Research/Monitoring	Undertake a visual assessment of the Brisbane Water Estuary and identify important landscape types and iconic views.	Waterway-wide/Catchment-wide	All	GCC		P32		$ 80,000		0	0	0	0	4	5	0	0	0	0	9	0		9
R05	Water and Sediment Quality	Research/Monitoring	Keep a log of the volumes and types of material removed from GPTs during routine maintenance and incorporate this information into the water quality monitoring program.	Catchment-wide	All	GCC		R02, R06, R04		$ 63,564		3	0	3	0	0	0	0	0	0	0	6	2		9
R20	Habitat and Species Conservation	Research/Monitoring	Monitor indicator organisms within all ecosystems (saltmarsh, seagrass, mangroves, intertidal mud, subtidal mud, intertidal rock) through time to assess effectiveness of management measures to protect biodiversity and maintain the ecological health of the Estuary.	Waterway-wide/Catchment-wide	All	GCC	CMA, DECCW, DII - Fisheries	R36, R37		$ 920,491		0	0	4	0	0	0	0	0	0	3	7	1		8.5
R29	Cultural Heritage	Research/Monitoring	Recognise the historic Aboriginal ownership and use of the area by undertaking research into local languages, customs and significant sites.	LGA-wide	All	GCC	DECCW	P31		$ 100,000	DEWHA Indigenous Heritage Program (up to $100,000)	0	0	0	0	5	0	0	0	0	0	5	2		8
R32	Recreational Usage	Research/Monitoring	Undertake an audit of the number, configuration and demand for existing moorings in Brisbane Water Estuary. Assess the need to increase the number of moorings and identify suitable locations with due consideration of the carrying capacity of the Estuary. Moorings should be concentrated in close proximity to associated shore-based facilities (e.g. dinghy storage racks).	Waterway-wide	All	NSW Maritime		P36, W65	R31	$ 20,000		0	1	-2	0	0	3	3	3	0	0	8	0		8
R25	Habitat and Species Conservation	Research/Monitoring	Monitor the status and extent of Caulerpa taxifolia in the Estuary and undertake a program of eradication.	Waterway-wide	All	DII - Fisheries	CMA	E13		$ 283,068	Recreational Fishing Trust	0	0	2	0	0	0	0	0	0	2	4	2		7
R15	Sedimentary Processes	Research/Monitoring	Investigate options for addressing/managing subsidence currently occurring near Erina Creek.	Muloora Rd, Springfield	2	GCC		W34		$ 55,000		1	1	0	0	0	0	1	0	0	0	3	2		6
R16	Sedimentary Processes	Research/Monitoring	Identify the cause of erosion under the bridge near Lara Street and outline measures to address this issue.	Park Bay	3	GCC		W34		$ 35,000		1	1	1	0	0	0	0	0	0	0	3	2		6

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R17	Sedimentary Processes	Research/Monitoring	Investigate options for implementation to address the erosion along Hardy's Bay Parade.	Killcare	6	GCC		W34		$ 299,455		1	1	1	0	0	0	0	0	0	0	3	2		6
R23	Habitat and Species Conservation	Research/Monitoring	Audit and assess the route used by the Palm Beach - Ettalong ferry. Where possible, the navigation route used by the ferry should avoid seagrass beds in this location.	Ettalong	6	NSW Maritime	DII - Fisheries	C08, R34		$ 15,000		0	2	2	0	0	0	-1	0	0	0	3	1		4.5
R34	Recreational Usage	Research/Monitoring	Audit and assess the route used by the Palm Beach - Ettalong ferry. Where possible, the navigation route used by the ferry should avoid popular bathing spots in this location.	Ettalong	6	NSW Maritime	GCC	C08, R23		$ 20,000		0	1	-2	0	0	0	2	0	0	0	1	2		4
R08	Sedimentary Processes	Research/Monitoring	For each significant dredging option considered for implementation, establish dredging trials to determine the effectiveness of proposed dredging activities.	Waterway-wide	All	LPMA, GCC	NSW Maritime	P07, R09, W18-W25		$ 120,000		-1	3	-2	0	0	0	3	0	0	0	3	0		3
R12	Sedimentary Processes	Research/Monitoring	Examine the feasibility of regularly removing accumulated sediments from Fagan's Bay and Woy Woy Bay with a view to using these areas as sediment traps to prevent sediment accretion in the main waterbody of the Estuary.	Fagan's Bay, Woy Woy Bay	1, 3	GCC	LPMA			$ 42,000		-1	1	3	0	0	0	0	1	0	0	4	-1		2.5
R35	Recreational Usage	Research/Monitoring	Investigate options for improving public access over the rail line to the foreshore adjacent to Railway Street.	Woy Woy	3	GCC	RailCorp			$ 50,000		0	0	-1	0	0	-1	1	0	0	0	-1	2		2
R07	Sedimentary Processes	Research/Monitoring	Undertake analysis incorporating radiocarbon dating of sediments associated with the mouth of Mudflat, RSL and Woy Woy Creeks to identify the rate of sedimentation.	Hardy's Bay, Woy Woy	All	GCC		W06, W27		$ 32,000		0	2	0	0	0	0	0	0	0	0	2	0		2
W01	Water and Sediment Quality	Works	Investigate options for implementing catchment based WSUD features in the catchment in order to manage stormwater quality and quantity, with a priority focus on the Narara and Erina Creek catchments, followed by Kincumber Creek catchment.	Catchment-wide	All	GCC		P05, R04-R06, R24, W04, W06, W07, W10, W13, W14		$ 748,611		5	4	5	0	0	1	2	1	0	0	18	2		21
W34	Sedimentary Processes	Works	Identify locations of bank erosion along creekline corridors and the Estuary foreshore. Design and implement remediation measures to address these issues, with re-establishment of native vegetation being the preferred option where feasible. Reference should be made to the shoreline assessment provided in Appendix H of the Brisbane Water Estuary Processes Study.	Erina Creek, Narara Creek, Woy Woy Creek, Hardy's Bay and Kincumber Creek as a priority	All	GCC	DWE, DECCW	P13, P14, R10, R17, W38, W41, W42, W45, W46, W48, W49, W53, W55		$ 2,053,952		3	4	4	1	1	1	2	0	0	0	16	2		19
W29	Sedimentary Processes	Works	Replace the existing shoreline protection works (boulders) with a stepped, vegetated dune that provides for public access and amenity.	Ettalong Beach	6	GCC	DECCW, LPMA	P10, P12, W28, W55, W97, W112	P42, R11	$ 1,358,910	NSW Coastal Management Program	0	3	2	2	1	3	3	1	0	0	15	1		16.5
W26	Sedimentary Processes	Works	Rehabilitate the eroding foreshores on the eastern shores of Hardy's Bay with natural vegetation typical of that naturally occurring in the area.	Eastern shores of Hardy's Bay	6	GCC	Volunteers	E09, P49		$ 20,000		2	4	3	2	0	2	0	0	0	0	13	1		14.5
W03	Water and Sediment Quality	Works	Provide for continued implementation of Council's Sewerage Enhancement Program and associated capital investments.	Catchment-wide	All	GCC				N/A		4	0	4	0	0	0	4	1	0	0	13	1		14.5
W71	Habitat and Species Conservation	Works	Where appropriate, rehabilitate saltmarsh habitats, with saltmarshes at Saratoga, Empire Bay, Davistown and Riley's Island addressed as a priority.	Saratoga, Empire Bay, Davistown and Riley's Island	All	GCC	DECCW, CMA, Bushcare Volunteers	W69, W70		$ 218,910	Caring for Our Country Grant	2	3	5	1	0	1	0	0	0	0	12	1		13.5
W84	Recreational Usage	Works	Provide boardwalks at sensitive foreshore locations to permit public access.	Estuary Foreshores	All	GCC		P50-P52, W94	W81	$ 1,079,401		2	1	2	1	1	2	3	0	0	0	12	1		13.5
W02	Water and Sediment Quality	Works	Install additional sewage pump-out facilities to reduce water pollution. These should be situated at locations accessible by a range of vessels.	Waterway-wide	All	NSW Maritime		E11, P55, W81		$ 629,701	NSW Maritime Better Boating Program (up to 50%)	4	0	3	0	0	0	4	0	0	0	11	1		12.5
W18	Sedimentary Processes	Works	Dredge the navigation channel up to 50,000m3 in the Estuary entrance as a priority.	Entrance	6	LPMA, GCC	NSW Maritime	R08, R09, W28	P06	$ 2,439,102		-1	4	0	0	-1	0	4	3	0	0	9	2		12
W28	Sedimentary Processes	Works	Undertake beach re-nourishment works at Ettalong Beach. The use of sand dredged from the Ettalong Shoals should be considered for this option.	Ettalong Beach	6	GCC	LPMA	P10, P12, W29, W55, W97, W112	P42, R11	$ 1,374,252		-1	4	0	0	-1	0	4	3	0	0	9	2		12
W83	Recreational Usage	Works	Identify priority, privately owned/managed parcels of foreshore land for acquisition and/or incorporation into publicly accessible foreshore land.	Estuary Foreshores	All	LPMA	GCC	P50-P52, W94	W81	$ 5,826,708		0	1	2	1	1	2	3	0	0	0	10	1		11.5
W86	Recreational Usage	Works	Provide paid, secure dinghy storage facilities at strategic locations around Brisbane Water Estuary. Suggested priority areas include Koolewong, around Gosford and Green Point.	Estuary Foreshores	All	GCC	NSW Maritime	C07	P35, P36	$ 355,940	NSW Maritime - Maritime Infrastructure Program	0	3	1	0	1	2	3	0	0	0	10	1		11.5
W113	Governance	Works	Establish a new position of River-Keeper for Brisbane Water following the NSW Maritime model.	Waterway-wide	All	NSW Maritime	GCC, CMA, DECCW	P58, P59, R36-R38		$ 1,059,401		1	1	1	1	1	1	1	0	2	2	11	0		11
W69	Habitat and Species Conservation	Works	Review existing sea walls in Council's foreshore parks to investigate possibility of returning natural foreshore and/or use of alternative materials that will: a) Increase the number of ecological niches, and b) Increase dissipation of wave energy. Reference should be made to DECCW's Environmentally Friendly Seawalls guidelines.	Estuary Foreshores	All	GCC	LPMA, DECCW, CMA	R15, W36, W43, W47, W54	W56, W41, R48	$ 579,701		1	3	5	-1	-1	1	0	0	0	0	8	2		11
W91	Recreational Usage	Works	Provide bins and bags for the disposal of animal faeces by dog walkers.	Catchment-wide	All	GCC		C10, W89		$ 120,940		3	0	1	0	0	1	3	0	0	0	8	2		11
W33	Sedimentary Processes	Works	Reinstate a vegetated, sandy shoreline at Pretty Beach similar to that present prior to the construction of Pretty Beach Road. The use of mangroves for revegetation works is discouraged due to their potential to outcompete and displace saltmarsh.	Pretty Beach	6	GCC	Volunteers	P49, W31, W32		$ 288,564		1	2	2	0	0	2	1	0	0	0	8	2		11
W76	Habitat and Species Conservation	Works	Rehabilitate the saltmarshes in Yattalunga Bay, to include the strategic removal of mangroves, weeding and control of nutrient inputs. Methods to address the source of weeds and nutrient inputs should also be considered.	Yattalunga Bay	2	GCC	Volunteers	R20, W01, W73	W68	$ 182,128	Caring for Our Country Grant	2	1	4	1	0	1	0	0	0	0	9	1		10.5
W27	Sedimentary Processes	Works	Undertake regular maintenance to remove sediments from the outlets of stormwater drains, starting with Hardy's Bay.	Catchment-wide	All	GCC		R10, W01		$ 529,701		2	3	2	3	0	0	0	0	0	0	10	0		10
W35	Sedimentary Processes	Works	Design and construct appropriate sediment control works to address sediment accretion issues at St Hubert's Island.	St Hubert's Island	4	GCC		P08, R13, W19		$ 558,910		2	2	3	0	0	0	0	0	0	0	7	2		10
W08	Water and Sediment Quality	Works	Provide more regular street cleaning to capture rubbish before it makes its way into the waterways.	Catchment-wide	All	GCC		C15, W93		$ 370,790		3	0	2	0	0	1	1	0	0	0	7	2		10
W12	Water and Sediment Quality	Works	Provide for ongoing maintenance of the opening(s) under the Brisbane Water Drive causeway to prevent siltation and maintain flushing.	Woy Woy	3	GCC		W11		$ 132,425		2	1	2	1	0	0	1	0	0	0	7	2		10

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W70	Habitat and Species Conservation	Works	Fence existing saltmarshes to prevent access by vehicles, bikes and domestic animals.	Estuary Foreshores	All	GCC	CMA, Bushcare Volunteers	W71		$ 408,910	Caring for Our Country Grant	1	3	4	1	0	-1	-1	0	0	1	8	1		9.5
W38	Sedimentary Processes	Works	Implement shoreline protection works to address the erosion and foreshore inundation along the foreshore at Yattalunga Reserve.	Yattalunga	2	GCC			W34	N/A		1	1	2	1	0	0	1	0	0	0	6	2		9
W39	Sedimentary Processes	Works	Rehabilitate eroded foreshore near 29 Araluen Drive, Killcare.	Killcare	6	GCC			W34	$ 80,000		1	1	2	1	0	0	1	0	0	0	6	2		9
W93	Recreational Usage	Works	Provide additional rubbish and recycling bins along the foreshore, focusing on access points and targeting heavily utilised foreshore reserves as a priority.	Estuary Foreshores	All	GCC			R31	$ 183,910		2	0	2	0	0	0	3	0	0	0	7	1		8.5
W65	Habitat and Species Conservation	Works	Replace existing swing moorings within the Estuary with more appropriate, seagrass friendly moorings.	Waterway-wide	All	NSW Maritime		R31, R32	P36	$ 79,455		0	3	2	0	0	0	0	0	0	0	5	2		8
W73	Habitat and Species Conservation	Works	Conduct weed control activities in Council's foreshore reserves.	Estuary Foreshores	All	GCC	Bushcare Volunteers	W72		$ 79,455		0	0	5	0	0	0	0	0	0	0	5	2		8
W77	Habitat and Species Conservation	Works	Provide alternative dinghy storage arrangements and fence the Endangered Ecological Community (EEC) at Mason Pde, Gosford. Ensure ongoing enforcement of prohibition of dinghy storage impacting on the EEC adjacent to the Scout Hall in this location.	Mason Pde, Gosford	2	GCC		C07, P35, P36, W86		$ 132,970		1	1	2	0	0	0	1	0	0	0	5	2		8
W79	Habitat and Species Conservation	Works	Replace existing tide gates/flaps fixed to stormwater outlets with fish friendly tide gates/flaps.	Estuary Foreshores	All	GCC	DII - Fisheries	W66, W67		$ 309,850	Recreational Fishing Trust	0	1	4	0	0	0	0	0	0	0	5	2		8
W37	Sedimentary Processes	Works	Remove disused pipes, posts, debris and other rubbish from the intertidal portion of the mudflats adjacent to Victory Pde, Tascott.	Tascott	2	GCC		W36		$ 55,000		1	1	2	0	0	1	0	0	0	0	5	2		8
W56	Foreshore Flooding/Inundation	Works	Seek to remediate scouring currently occurring behind the existing seawall in Illoura Reserve. This may necessitate replacement of the existing seawall with a new, environmentally friendly seawall structure.	Davistown	All	GCC	DII - Fisheries	W47, W48	W34	N/A		0	1	3	2	0	0	0	0	0	0	6	1		7.5
W68	Habitat and Species Conservation	Works	Investigate the issue of mangrove habitat expansion at the expense of other estuarine habitats (esp. saltmarsh). Key locations where this process is occurring should be identified and appropriate mangrove control management actions developed in conjunction with DII Fisheries.	Waterway-wide	All	GCC	DII - Fisheries, Volunteers	R20, W57, W58, W61, W76		$ 258,910		0	1	4	1	0	0	0	0	0	0	6	1		7.5
W72	Habitat and Species Conservation	Works	Conduct feral animal control in Council's foreshore reserves.	Estuary Foreshores	All	GCC		W73		$ 211,880		1	0	5	0	0	0	0	0	0	0	6	1		7.5
W04	Water and Sediment Quality	Works	Provide additional sediment traps for locations draining to Correa Bay. Sediment traps should target catchment inflows from the Bulls Hill Quarry and Garbage tip.	Correa Bay	3	GCC		W01, W22		$ 179,455		2	1	2	0	0	0	1	0	0	0	6	1		7.5
W06	Water and Sediment Quality	Works	Install and maintain as required sediment traps targeting stormwater flows draining from the escarpment at Hardy's Bay.	Hardy's Bay	6	GCC		W01		$ 163,564		2	1	2	0	0	0	1	0	0	0	6	1		7.5
W07	Water and Sediment Quality	Works	Provide ongoing maintenance of existing sediment traps in locations draining to Horsfield Bay.	Horsfield Bay	3	GCC		W01		$ 63,564		2	1	2	0	0	0	1	0	0	0	6	1		7.5
W59	Foreshore Flooding/Inundation	Works	Restore flows to Woy Woy Creek by de-commissioning the dam at the former abattoir site.	Woy Woy Creek	3	GCC	DWE	W40		N/A		1	1	1	1	0	0	0	0	0	0	4	2		7
W104	Recreational Usage	Works	Improve public access along the foreshore reserve between Ironbark Point and Rocky Point. Assess the feasibility of installing a boardwalk, undertaking foreshore stabilisation works and/or creating a public path in front of houses between 36-40 Asca Drive.	Green Point	2	GCC		W82		$ 280,940		0	1	1	0	0	1	1	0	0	0	4	2		7
W30	Sedimentary Processes	Works	Remove the sandstone and cement abutments from the Pretty Beach jetty and adjacent to the pool.	Pretty Beach	6	GCC		P39, W31		$ 500,000		0	1	1	0	0	1	1	0	0	0	4	2		7
W46	Sedimentary Processes	Works	Investigate the cause of erosion around the Blackwall Point boat ramp and develop measures to address this issue. Any necessary repairs to stabilise the foreshore and the adjacent roadway should be undertaken.	Blackwall	4	GCC		W09, W34		$ 255,940		1	1	1	0	0	0	1	0	0	0	4	2		7
W55	Sedimentary Processes	Works	Identify the cause of foreshore erosion in Lance Webb Reserve and develop and implement measures to stabilise the foreshore.	Ettalong	6	GCC		W97, W112	P42, R11	$ 279,455	NSW Coastal Management Program	1	1	1	0	0	0	1	0	0	0	4	2		7
W11	Water and Sediment Quality	Works	Install an additional opening/culvert under the Brisbane Water Drive causeway with a view to increasing flushing of Woy Woy Inlet and Woy Woy Bay and promoting scouring of the adjacent navigational channels. This option will require detailed investigations to confirm the feasibility and long term sustainabilityprior to proceeding with implementation.	Woy Woy	3	GCC	RailCorp	W12		$ 500,000		2	2	1	1	0	0	1	0	0	0	7	0		7
W05	Water and Sediment Quality	Works	Advertise and provide signage for boat pump-out facilities.	Gosford, Hardy's Bay	2, 6	NSW Maritime		E11, P55, W02, W81		$ 70,470		3	0	2	0	0	0	2	0	0	0	7	0		7
W41	Sedimentary Processes	Works	Undertake foreshore stabilisation works in the Punt Bridge area incorporating revegetation to address erosion issues.	East Gosford	2	GCC	Volunteers		W34	$ 205,940		1	1	1	0	0	1	1	0	0	0	5	1		6.5
W47	Sedimentary Processes	Works	Seek to remediate scouring currently occurring behind the existing seawall in Illoura Reserve. This may necessitate replacement of the existing seawall with a new, environmentally friendly seawall structure.	Davistown	5	GCC		W48, W56	W34	$ 632,425		1	2	1	0	0	0	1	0	0	0	5	1		6.5
W17	Water and Sediment Quality	Works	Implement a program of maintenance to address the accumulation of litter in the open drain near Beach Street. Long term management of this issue should also be considered, for example, public education and/or the implementation of additional gross pollutant traps.	Ettalong	6	GCC		C15, W01		$ 138,564		1	0	1	0	0	1	1	0	0	1	5	1		6.5
W63	Foreshore Flooding/Inundation	Works	Investigate and implement options to address the issue of drainage from private properties along Mundoora Avenue onto the public reserve.	Yattalunga	2	GCC				$ 132,970		1	1	1	0	0	0	1	-1	0	0	3	2		6
W75	Habitat and Species Conservation	Works	Where possible, re-introduce native cockles and other shellfish to suitable depleted habitats (such as seagrass beds in Hardy's Bay, Pretty Beach and Riley's Bay).	Hardy's Bay, Pretty Beach and Riley's Bay	6	DII - Fisheries				$ 173,910		1	0	2	0	0	0	0	0	0	0	3	2		6

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W82	Recreational Usage	Works	Seek to provide a publicly accessible pathway along the entire Estuary foreshore. This should be approached in a strategic fashion incorporating: a) Linkages with existing cycleways, pathways and public transport in the wider catchment, b) Safety by Design (e.g. through the provision of lighting), and c) Consideration of environmental constraints (e.g. gridded/light permeable boardwalks may be more suitable in ecologically sensitive areas).	Estuary Foreshores	All	GCC	LPMA	P50-P52, W83, W84, W94		$ 1,324,252		-1	-1	0	0	1	2	5	0	0	0	6	0		6
W94	Recreational Usage	Works	Provide additional facilities for disabled and less mobile people, to include access ramps, seating, disabled parking etc.	Fagan's Bay, Woy Woy, Ettalong	All	GCC		W84, W85	R31	$ 1,235,641		0	0	0	0	0	0	3	0	0	0	3	2		6
W114	Sedimentary Processes	Works	Dredge to improve access to the Volunteer Coastal Patrol in the region of the boat ramp and surrounds. The dredging should be sufficient to permit access over the full tidal cycle.	Point Clare	2	GCC	NSW Maritime, LPMA	R08		$ 170,000		-1	1	0	0	0	0	3	0	0	0	3	2		6
W40	Sedimentary Processes	Works	Restore flows to Woy Woy Creek by de-commissioning the dam at the former abattoir site with a view to providing for natural scouring of the creek channel.	Woy Woy	3	GCC		W59		$ 120,000		1	1	0	1	0	0	0	0	0	0	3	2		6
W51	Sedimentary Processes	Works	Implement measures to dissipate the energy of stormwater flows and prevent scour associated with the stormwater outlet near the corner of Jirramba and Mimosa Avenues.	Saratoga	2	GCC		W01	R10, W34	$ 55,000		1	1	1	0	0	0	0	0	0	0	3	2		6
W53	Sedimentary Processes	Works	Undertake bank stabilisation works to address the erosion occurring in the creek in the region of Avoca Drive and Sun Valley Drive.	Green Point	2	GCC			W34	$ 212,970		1	1	1	0	0	0	0	0	0	0	3	2		6
W103	Recreational Usage	Works	Undertake a regular program of maintenance for the Yattalunga jetty and tidal pool to remove accreted sediments and clean out weed.	Yattalunga	2	GCC				$ 476,731		1	1	0	0	0	1	1	0	0	0	4	1		5.5
W85	Recreational Usage	Works	Enforce the replacement of fixed public jetties with floating pontoons.	Waterway-wide	All	LPMA	GCC	P36, P46, W94		$ 2,330,683		0	2	0	0	-2	2	2	0	0	0	4	1		5.5
W42	Sedimentary Processes	Works	Undertake foreshore stabilisation works to address erosion currently occurring near Goondi Close.	Horsfield Bay	3	GCC			W34	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W45	Sedimentary Processes	Works	Undertake foreshore stabilisation works to address erosion currently occurring in Palermo Reserve, Empire Bay Drive.	Daleys Point	4	GCC			W34	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W48	Sedimentary Processes	Works	Implement foreshore stabilisation works to prevent further erosion of the Illoura Reserve foreshore between Lintern Street and 28 Molinya Road.	Davistown	5	GCC	Volunteers	W47, W56	W34	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W49	Sedimentary Processes	Works	Implement foreshore stabilisation works to prevent further erosion of the shoreline near Rip Road reserve.	Blackwall	4	GCC	Volunteers		W34	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W10	Water and Sediment Quality	Works	Remediate (or pipe) open drains and install sediment traps for those drains running from Wilkie King Ave and Mundoora Ave, Yattalunga.	Yattalunga	2	GCC		W01		$ 143,861		2	1	1	0	0	0	0	0	0	0	4	1		5.5
W13	Water and Sediment Quality	Works	Develop and implement measures to address stormwater quality issues associated with runoff from fire trails on Blackwall Mountain.	Blackwall	4	GCC	DECCW	W01, R24		$ 138,564		1	2	1	0	0	0	0	0	0	0	4	1		5.5
W14	Water and Sediment Quality	Works	Develop and implement measures to address stormwater quality issues associated with runoff from the access road and fire trails near Fisherman's Parade.	Daleys Point	6	GCC	DECCW	W01, R25		$ 138,564		1	2	1	0	0	0	0	0	0	0	4	1		5.5
W15	Water and Sediment Quality	Works	Seal the Hawke Street car park to prevent erosion into Kincumber Creek. The use of permeable pavement is recommended over impermeable	Kincumber	5	GCC		W01, R26		$ 163,564		1	1	1	0	0	1	0	0	0	0	4	1		5.5
W16	Water and Sediment Quality	Works	Investigate and implement measures to improve flow/drainage in the open channel near Mundoora Avenue.	Yattalunga	2	GCC				$ 150,000		1	1	1	1	0	0	0	0	0	0	4	1		5.5
W60	Foreshore Flooding/Inundation	Works	Where possible, provide for managed retreat of infrastructure from foreshore areas likely to be affected by sea level rise.	Estuary Foreshores	All	GCC	DECCW		P43	$ 3,428,204		0	3	3	5	-3	0	-3	-3	0	0	2	2		5
W101	Recreational Usage	Works	Provide improved, safe access for recreational users accessing the foreshore and waterway near Victory Pde, Tascott, via re-configuration of the existing rock wall.	Tascott	2	GCC			W36, W37	$ 275,000		0	-1	0	1	0	1	1	0	0	0	2	2		5
W112	Recreational Usage	Works	Identify measures to improve public access to Lance Webb Reserve and the beach in this location.	Ettalong	6	GCC		W82		$ 50,000		0	0	1	0	0	0	1	0	0	0	2	2		5
W88	Recreational Usage	Works	Provide navigational markers for the following locations: - The sand bar in Correa Bay, and - The unmarked rock outcrop in Horsfield Bay.	Correa Bay, Horsfield Bay	3	NSW Maritime		W87	W88	$ 20,000		0	0	1	0	0	0	1	0	0	0	2	2		5
W43	Sedimentary Processes	Works	Develop and implement a long term solution to replace the currently failing seawall in Lions Memorial Park on Brick Wharf Road. Any option identified should wherever possible incorporate environmentally friendly features.	Woy Woy	4	GCC	DECCW	P62, W80	W34	$ 658,910		1	1	1	0	0	1	1	0	0	0	5	0		5
W87	Recreational Usage	Works	Ensure that the navigation markers are moved in accordance with movement of the associated shoals.	Waterway-wide	All	NSW Maritime				$ 158,910		0	0	0	-1	0	0	4	0	0	0	3	1		4.5
W92	Recreational Usage	Works	Instead of collecting rubbish from the Estuary foreshores via beach raking, collect by hand (to avoid ecological impacts).	Estuary Foreshores	All	GCC	Volunteers, Work for the Dole Program			$ 476,731		0	1	2	0	0	0	0	0	0	0	3	1		4.5
W95	Recreational Usage	Works	Provide special parking for people transferring small children to prams at key recreational areas.	Fagan's Bay, Ettalong	All	GCC		W96	R31	$ 25,000		0	0	0	0	0	0	3	0	0	0	3	1		4.5
W96	Recreational Usage	Works	Provide short-term 'loading zones' for recreational users (un)loading bikes or other equipment immediately adjacent to heavily utilised recreational sites.	Estuary Foreshores	All	GCC		W95	R31	$ 25,000		0	0	0	0	0	0	3	0	0	0	3	1		4.5
W115	Sedimentary Processes	Works	Dredge to improve access to the boat pump-out and other facilities in Gosford Harbour. The dredging should be sufficient to permit access over the full tidal cycle.	Gosford Harbour	2	GCC	LPMA	R08		$ 170,000		-1	1	0	0	0	0	3	0	0	0	3	1		4.5
W21	Sedimentary Processes	Works	Dredge from the Correa Bay boat ramp to the entrance of Woy Woy Creek, to extend 300m up the creek channel, with a view to improving drainage and access at this location.	Woy Woy	3	LPMA, GCC	NSW Maritime	R08		$ 500,000		-1	1	1	1	0	0	1	0	0	0	3	1		4.5
W22	Sedimentary Processes	Works	Dredge from Bulls Hill to Correa Bay to remove sediment that has been deposited there in the last few years.	Woy Woy	3	LPMA, GCC		W04		$ 500,000		-1	1	1	1	0	0	1	0	0	0	3	1		4.5
W44	Sedimentary Processes	Works	Replace collapsed stormwater drain running between the two ovals in Austin Butler Reserve and remove accreted sediments. There is a preference for the use of a natural vegetated swale and/or small wetland.	Woy Woy	4	GCC				$ 100,000		1	1	-1	1	0	0	1	0	0	0	3	1		4.5
W52	Sedimentary Processes	Works	Investigate and implement measures to address siltation currently occurring in the open drain along the foreshore between Mundoora Access and Wilkie King Avenue. Both removal of the accreted sediments and measures to address sediment sources should be considered. There is a preference for the use of a natural vegetated swale and/or small wetland.	Yattalunga	2	GCC		W01	R10	$ 132,970		1	1	1	0	0	0	0	0	0	0	3	1		4.5
W62	Foreshore Flooding/Inundation	Works	Investigate and implement options to improve flow from the stormwater outlets located in the Lions Memorial Park on Brick Wharf Road, to include a program of ongoing weed removal. A fish friendly tide gate/flap should also be considered to prevent estuarine ingress when the outlet is inundated.	Woy Woy	4	GCC	Volunteers	W43, W80		$ 205,940		1	0	-1	1	0	0	0	0	0	0	1	2		4
W66	Habitat and Species Conservation	Works	Provide fish friendly structures where new instream structures are being constructed.	Catchment Tributaries	All	GCC, RTA	DII - Fisheries	W67		$ 635,641	Recreational Fishing Trust	0	0	1	0	0	0	0	0	0	0	1	2		4
W67	Habitat and Species Conservation	Works	Identify existing instream infrastructure (e.g. weirs and culverts) for replacement or retrofitting to fish friendly status.	Catchment Tributaries	All	GCC, RTA	DII - Fisheries	W66		$ 645,641	Recreational Fishing Trust	0	0	1	0	0	0	0	0	0	0	1	2		4

Option ID	Management Goal Addressed	Management Category	Strategy Outline	Location	Zone	Primary Responsibility	Secondary Responsibility	Cross Reference with Option:	Dependency on Option:	Net Present Value	Potential Funding Stream	Water & Sediment Quality	Sedimentary Processes	Ecological Processes	Foreshore Flooding / Inundation	Cultural Heritage	Visual Amenity	Recreational Usage	Development	Governance	Information, Communications and Education	Raw Benefit Index	Council / DECCW Response	Community Response	Adjusted Benefit Index
W74	Habitat and Species Conservation	Works	Where feasible, clean up both active and inactive oyster leases to remove rubble, oyster shells and other rubbish.	Waterway-wide	All	DII - Fisheries	Volunteers	P17		$ 158,910		1	2	0	0	-1	1	1	0	0	0	4	0		4
W78	Habitat and Species Conservation	Works	Undertake program of weed removal in Horsfield Bay and Correa Bay foreshore reserves.	Horsfield Bay, Correa Bay	3	GCC	Volunteers	W73		N/A		0	-1	1	0	0	1	0	0	0	0	1	2		4
W80	Habitat and Species Conservation	Works	Undertake program of weed removal in Lions Memorial Park on Brick Wharf Road, around the boat ramp in particular.	Woy Woy	4	GCC	Volunteers	W73		N/A		0	-1	1	0	0	1	0	0	0	0	1	2		4
W119	Sedimentary Processes	Works	Extend dredging of the Entrance Reach further upstream past Kourung Gourung Point between Ettalong Beach and Pretty Beach with a view to improving navigation.	Entrance	6	GCC	LPMA	R08, R09	P06, P07	$ 1,559,401		-1	2	-1	0	-1	0	2	0	0	0	1	2		4
W109	Recreational Usage	Works	Investigate and implement suitable options for improving drainage of the oval located near Willaroo Road.	Saratoga	4	GCC				$ 355,940		0	0	0	1	0	0	1	0	0	0	2	1		3.5
W111	Recreational Usage	Works	Remove and dispose of disused boat trailer and floating pontoon (Hawke Street).	Kincumber	5	GCC	LPMA			$ 20,000		0	0	0	0	0	1	1	0	0	0	2	1		3.5
W97	Recreational Usage	Works	Provide additional access points to Ettalong Beach from Lance Webb Reserve.	Ettalong	6	GCC		P10, P12, W29, W55, W97	P42, R11	$ 55,000		0	-1	1	0	0	0	2	0	0	0	2	1		3.5
W120	Sedimentary Processes	Works	Dredge to improve access to the boat pump-out and other facilities in Hardy's Bay. The dredging should be sufficient to permit access over the full tidal cycle.	Hardy's Bay	6	GCC	LPMA	R08		$ 200,000		0	1	0	0	0	0	1	0	0	0	2	1		3.5
W23	Sedimentary Processes	Works	Deepen and widen the outlets of Mudflat and RSL Creeks in Hardy's Bay so that both creeks restore tidal flushing. The efficacy of this option in improving flushing should be assessed prior to undertaking the works.	Mudflat and RSL Creeks	6	LPMA, GCC		R07, W06, W27, W34		$ 160,000		-1	1	1	1	0	0	0	0	0	0	2	1		3.5
W54	Sedimentary Processes	Works	Investigate and implement measures to address the eroding seawall located near Araluen Drive on the southern side of Hardy's Bay. Preferred options include re-establishment of native vegetation or an environmentally friendly seawall.	Hardy's Bay	6	GCC			W34	$ 425,940		0	1	1	0	0	0	0	0	0	0	2	1		3.5
W100	Recreational Usage	Works	Progress towards removal of oyster leases in Lintern Channel, west of Empire Bay, Riley's Island and Pelican Island.	Lintern Chanel, Empire Bay, Pelican Island	2, 4	DII - Fisheries		P17, W74		$ 60,000		0	1	3	0	-1	2	0	-2	0	0	3	0		3
W19	Sedimentary Processes	Works	Undertake an ongoing program of maintenance to restore the drainage canals of St Hubert's Island to their original design criteria.	St Hubert's Island	4	GCC		R08, R09		$ 2,074,252		-1	2	-2	0	0	0	1	0	0	0	0	2		3
W31	Sedimentary Processes	Works	Remove accreted sediments from the eastern shoreline along Pretty Beach, including those that have built up in the swimming pool.	Pretty Beach	6	GCC		P39, W30, W32		$ 264,850		-1	1	2	0	0	0	1	0	0	0	3	0		3
W32	Sedimentary Processes	Works	Dredge sediments around the boat launching pontoon at Pretty Beach to enable boats to tie up on both sides of the pontoon.	Pretty Beach	6	GCC		W31, W33		$ 1,326,282		-1	1	2	0	0	0	1	0	0	0	3	0		3
W58	Foreshore Flooding/Inundation	Works	Control mangrove growth where they are affecting key drainage channels.	Catchment Tributaries	All	GCC	Volunteers	W57, W61		$ 288,068	NSW Floodplain Management Program (pending outcome of Brisbane Water Floodplain Risk Management Study and Plan)	-1	1	-2	3	0	0	0	0	0	0	1	1		2.5
W64	Foreshore Flooding/Inundation	Works	Undertake to improve drainage in the creek by dredging accreted sediments near Avoca and Sun Valley Drives.	Green Point	2	GCC		W01		$ 55,000		0	1	-1	1	0	0	0	0	0	0	1	1		2.5
W102	Recreational Usage	Works	Provide recreational facilities including picnic benches and BBQs at Yattalunga Reserve.	Yattalunga Reserve	2	GCC	LPMA		P41, R31	$ 285,395		0	0	0	0	0	0	1	0	0	0	1	1		2.5
W110	Recreational Usage	Works	Provide a shared pedestrian pathway/cycleway in the reserve near Carrak Road to improve recreational access and link with other areas.	Kincumber	5	GCC		W82		$ 302,970		0	0	0	0	0	0	1	0	0	0	1	1		2.5
W98	Recreational Usage	Works	Provide additional public open space areas incorporating walking tracks in the Woy Woy area (to the waterfall and through the former abattoir site).	Woy Woy	3	GCC		W82, W99		$ 461,880		0	-1	0	0	0	1	1	0	0	0	1	1		2.5
W116	Sedimentary Processes	Works	Dredge to improve navigation and access to boat ramps in Cockle Channel.	Davistown	5	GCC	LPMA	R08, R09	P07	$ 647,276		-1	1	0	0	0	0	1	0	0	0	1	1		2.5
W117	Sedimentary Processes	Works	Dredge to improve navigation in Woy Woy Channel near Pelican Island.	Woy Woy	4	GCC	LPMA	R08, R09	P07	$ 647,276		-1	1	0	0	0	0	1	0	0	0	1	1		2.5
W09	Water and Sediment Quality	Works	Provide kerb and guttering for those roads that are currently unsealed/unfinished.	Woy Woy, Blackwall	All	GCC				$ 1,570,790		2	2	-4	-1	0	1	0	1	0	0	1	1		2.5
W36	Sedimentary Processes	Works	Dredge built-up sand associated with the stormwater outlet between 29-33 Victory Pde, Tascott.	Tascott	2	LPMA, GCC		W34, W37, W101		$ 120,000		-1	1	1	1	0	0	0	0	0	0	2	0		2
W57	Foreshore Flooding/Inundation	Works	Remove the mangroves from Turo Creek to permit the passage of flood flows from the catchment.	Pretty Beach	6	GCC	Volunteers	W61	W58	$ 97,970	NSW Floodplain Management Program (pending outcome of Brisbane Water Floodplain Risk Management Study and Plan)	-1	1	-1	1	0	0	0	0	0	0	0	1		1.5
W61	Foreshore Flooding/Inundation	Works	Undertake to remove mangroves currently impeding flow out of the stormwater outlets located near the train station on Railway Street.	Woy Woy	3	GCC		W57	W58	$ 80,000	NSW Floodplain Management Program (pending outcome of Brisbane Water Floodplain Risk Management Study and Plan)	-1	1	-1	1	0	0	0	0	0	0	0	1		1.5
W107	Recreational Usage	Works	Provide dedicated parking for users of the boat ramp near Punt Bridge.	Central Coast Hwy	2	GCC			P41	$ 132,970		0	0	-1	0	0	0	1	0	0	0	0	1		1.5
W25	Sedimentary Processes	Works	Dredge in the Saratoga (Paddy's and Lintern) Channel(s) and around the boat ramps to permit better access.	Saratoga and Green Point	2	LPMA, GCC	NSW Maritime	R08, R09		$ 600,000		-1	1	-1	0	0	0	1	0	0	0	0	1		1.5
W50	Sedimentary Processes	Works	Undertake minor dredging works to improve access to the Centennial Street boat ramp.	Saratoga	4	GCC				$ 80,000		-1	1	-1	0	0	0	1	0	0	0	0	1		1.5
W118	Sedimentary Processes	Works	Dredge to improve navigation in Woy Woy Bay.	Woy Woy Bay	3	GCC	LPMA	R08		$ 200,000		-1	1	0	0	0	0	1	0	0	0	1	0		1
W105	Recreational Usage	Works	Extend Orana St boat ramp to permit access at low tide.	Green Point	2	GCC				$ 75,000		0	-1	-1	0	0	0	1	0	0	0	-1	1		0.5
W20	Sedimentary Processes	Works	Dredge the sand bars in the channel between Blackwall Point and Allfield Road, Woy Woy, with a view to improving navigation.	Woy Woy	3	LPMA, GCC	NSW Maritime	R08		$ 360,000		-1	1	-2	0	0	0	1	0	0	0	-1	1		0.5
W89	Recreational Usage	Works	Provide additional off-leash dog walking areas.	Catchment-wide	All	GCC		C10, W91		$ 20,000		-2	0	-1	0	0	0	3	0	0	0	0	0		0
W24	Sedimentary Processes	Works	Deepen and widen the entrance to Hardy's Bay to permit greater tidal flushing. The efficacy of this option in improving flushing should be assessed prior to undertaking the works. In addition, the environmental aspects must also be considered.	Hardy's Bay	6	LPMA, GCC		R08		$ 500,000		-1	2	-2	0	0	0	1	0	0	0	0	0		0
W106	Recreational Usage	Works	Provide for regular removal of accumulated seagrass wrack from the beach opposite the Sailing Club at this popular recreational area.	Mason Pde and Dane Dr, Gosford	2	GCC				$ 132,425		0	0	-1	0	0	1	1	0	0	0	1	-1		-0.5
W99	Recreational Usage	Works	Acquire the former abattoir site for incorporation into Council's system of public reserves.	Woy Woy	3	GCC	LPMA	W98		$ 3,500,000		-4	0	1	0	0	0	1	0	0	0	-2	1		-0.5

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W81	Recreational Usage	Works	Seek to provide additional facilities for the boating community to include slipways, shipwright services, travel lifts, re-fuelling areas and hard stand areas. The form and location of these additional facilities should be such that they are accessible by a range of vessels over the full tidal cycle.	Estuary Foreshores/Waterway-wide	All	LPMA	GCC	P35, P36, R32, W02, W85	R31, P41	$ 2,330,683	NSW Maritime - Maritime Infrastructure Program	-3	-2	-2	0	0	-2	4	4	0	0	-1	0		-1
W108	Recreational Usage	Works	Undertake review of need requirements for the tidal baths located near Brisbane Water Drive. An upgrade from netting to stainless steel bars should be considered.	Woy Woy	4	GCC			P41	$ 355,940		0	-1	-1	0	0	0	1	0	0	0	-1	-1		-2.5
W121	Sedimentary Processes		Investigate options to address access and amenity issues associated with the blockage of the entrance to Riley's Bay and sediment accretion in this area.	Riley's Bay	6	GCC	LPMA	R08		$ 50,000		-1	1	0	0	0	0	1	0	0	0	1	0		1

Appendix J

Management Options – Ranked by Management Zone

Option ID	Management Goal Addressed	Management Category	Strategy Outline	Location	Zone	Primary Responsibility	Secondary Responsibility	Cross Reference with Option:	Dependency on Option:	Net Present Value	Potential Funding Stream	Water & Sediment Quality	Sedimentary Processes	Ecological Processes	Foreshore Flooding / Inundation	Cultural Heritage	Visual Amenity	Recreational Usage	Development	Governance	Information, Communications and Education	Raw Benefit Index	Council / DECCW Response	Community Response	Adjusted Benefit Index
P13	Sedimentary Processes	Planning	Geomorphological assessment required to develop options to address the bank erosion occurring upstream of Ann Close Reserve on Narara Creek.	Narara	1	GCC			P01, W34	$ 45,000		1	1	1	0	0	1	1	0	0	0	5	2		8
P57	Commercial Development	Planning	Use the findings of the Brisbane Water Estuary Processes Study to inform the masterplanning process for the Gosford city centre.	Gosford	2	GCC	DoP	P56		N/A		1	1	2	2	3	3	3	3	0	3	21	2		24
P56	Commercial Development	Planning	Develop a strategy to promote and enhance the connection between the Gosford city centre and the Brisbane Water Estuary.	Gosford	2	GCC	DoP	P57		N/A		0	0	0	0	5	3	5	3	0	2	18	1		19.5
P14	Sedimentary Processes	Planning	Continue to enforce prohibition of mowing to the waters edge in both public and private foreshore areas in order to minimise foreshore erosion and impacts on estuarine vegetation.	Green Point	2	GCC		E09, R22		$ 158,910		2	3	2	1	0	2	0	0	0	1	11	2		14
W76	Habitat and Species Conservation	Works	Rehabilitate the saltmarshes in Yattalunga Bay, to include the strategic removal of mangroves, weeding and control of nutrient inputs. Methods to address the source of weeds and nutrient inputs should also be considered.	Yattalunga Bay	2	GCC	Volunteers	R20, W01, W73	W68	$ 182,128	Caring for Our Country Grant	2	1	4	1	0	1	0	0	0	0	9	1		10.5
R14	Sedimentary Processes	Research/Monitoring	Investigate options for replacing or modifying the existing seawall along Dane and Mason Parades with an environmentally friendly seawall. The options should aim to dissipate incoming waves and address erosion occurring at this location.	Gosford	2	GCC		E10, P48, W69		$ 60,000	NSW Coastal Management Program	1	2	2	1	0	1	1	0	0	0	8	1		9.5
W38	Sedimentary Processes	Works	Implement shoreline protection works to address the erosion and foreshore inundation along the foreshore at Yattalunga Reserve.	Yattalunga	2	GCC			W34	N/A		1	1	2	1	0	0	1	0	0	0	6	2		9
W77	Habitat and Species Conservation	Works	Provide alternative dinghy storage arrangements and fence the Endangered Ecological Community (EEC) at Mason Pde, Gosford. Ensure ongoing enforcement of prohibition of dinghy storage impacting on the EEC adjacent to the Scout Hall in this location.	Mason Pde, Gosford	2	GCC		C07, P35, P36, W86		$ 132,970		1	1	2	0	0	0	1	0	0	0	5	2		8
W37	Sedimentary Processes	Works	Remove disused pipes, posts, debris and other rubbish from the intertidal portion of the mudflats adjacent to Victory Pde, Tascott.	Tascott	2	GCC		W36		$ 55,000		1	1	2	0	0	1	0	0	0	0	5	2		8
W104	Recreational Usage	Works	Improve public access along the foreshore reserve between Ironbark Point and Rocky Point. Assess the feasibility of installing a boardwalk, undertaking foreshore stabilisation works and/or creating a public path in front of houses between 36-40 Asca Drive.	Green Point	2	GCC		W82		$ 280,940		0	1	1	0	0	1	1	0	0	0	4	2		7
W41	Sedimentary Processes	Works	Undertake foreshore stabilisation works in the Punt Bridge area incorporating revegetation to address erosion issues.	East Gosford	2	GCC	Volunteers		W34	$ 205,940		1	1	1	0	0	1	1	0	0	0	5	1		6.5
W63	Foreshore Flooding/Inundation	Works	Investigate and implement options to address the issue of drainage from private properties along Mundoora Avenue onto the public reserve.	Yattalunga	2	GCC				$ 132,970		1	1	1	0	0	0	1	-1	0	0	3	2		6
R15	Sedimentary Processes	Research/Monitoring	Investigate options for addressing/managing subsidence currently occurring near Erina Creek.	Muloora Rd, Springfield	2	GCC		W34		$ 55,000		1	1	0	0	0	0	1	0	0	0	3	2		6
W114	Sedimentary Processes	Works	Dredge to improve access to the Volunteer Coastal Patrol in the region of the boat ramp and surrounds. The dredging should be sufficient to permit access over the full tidal cycle.	Point Clare	2	GCC	NSW Maritime, LPMA	R08		$ 170,000		-1	1	0	0	0	0	3	0	0	0	3	2		6
W51	Sedimentary Processes	Works	Implement measures to dissipate the energy of stormwater flows and prevent scour associated with the stormwater outlet near the corner of Jirramba and Mimosa Avenues.	Saratoga	2	GCC		W01	R10, W34	$ 55,000		1	1	1	0	0	0	0	0	0	0	3	2		6
W53	Sedimentary Processes	Works	Undertake bank stabilisation works to address the erosion occurring in the creek in the region of Avoca Drive and Sun Valley Drive.	Green Point	2	GCC			W34	$ 212,970		1	1	1	0	0	0	0	0	0	0	3	2		6
W103	Recreational Usage	Works	Undertake a regular program of maintenance for the Yattalunga jetty and tidal pool to remove accreted sediments and clean out weed.	Yattalunga	2	GCC				$ 476,731		1	1	0	0	0	1	1	0	0	0	4	1		5.5
P05	Water and Sediment Quality	Planning	Investigate the need for sediment traps and other stormwater management measures to control any erosion and sedimentation from sloping lands draining to the stormwater outlet opposite Byalla Lane.	Saratoga	2	GCC			R24, W01	$ 17,500		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W10	Water and Sediment Quality	Works	Remediate (or pipe) open drains and install sediment traps for those drains running from Wilkie King Ave and Mundoora Ave, Yattalunga.	Yattalunga	2	GCC		W01		$ 143,861		2	1	1	0	0	0	0	0	0	0	4	1		5.5
W16	Water and Sediment Quality	Works	Investigate and implement measures to improve flow/drainage in the open channel near Mundoora Avenue.	Yattalunga	2	GCC				$ 150,000		1	1	1	1	0	0	0	0	0	0	4	1		5.5
W101	Recreational Usage	Works	Provide improved, safe access for recreational users accessing the foreshore and waterway near Victory Pde, Tascott, via re-configuration of the existing rock wall.	Tascott	2	GCC			W36, W37	$ 275,000		0	-1	0	1	0	1	1	0	0	0	2	2		5
W115	Sedimentary Processes	Works	Dredge to improve access to the boat pump-out and other facilities in Gosford Harbour. The dredging should be sufficient to permit access over the full tidal cycle.	Gosford Harbour	2	GCC	LPMA	R08		$ 170,000		-1	1	0	0	0	0	3	0	0	0	3	1		4.5
W52	Sedimentary Processes	Works	Investigate and implement measures to address siltation currently occurring in the open drain along the foreshore between Mundoora Access and Wilkie King Avenue. Both removal of the accreted sediments and measures to address sediment sources should be considered. There is a preference for the use of a natural vegetated swale and/or small wetland.	Yattalunga	2	GCC		W01	R10	$ 132,970		1	1	1	0	0	0	0	0	0	0	3	1		4.5
W64	Foreshore Flooding/Inundation	Works	Undertake to improve drainage in the creek by dredging accreted sediments near Avoca and Sun Valley Drives.	Green Point	2	GCC		W01		$ 55,000		0	1	-1	1	0	0	0	0	0	0	1	1		2.5
W102	Recreational Usage	Works	Provide recreational facilities including picnic benches and BBQs at Yattalunga Reserve.	Yattalunga Reserve	2	GCC	LPMA		P41, R31	$ 285,395		0	0	0	0	0	0	1	0	0	0	1	1		2.5
W36	Sedimentary Processes	Works	Dredge built-up sand associated with the stormwater outlet between 29-33 Victory Pde, Tascott.	Tascott	2	LPMA, GCC		W34, W37, W101		$ 120,000		-1	1	1	1	0	0	0	0	0	0	2	0		2
W107	Recreational Usage	Works	Provide dedicated parking for users of the boat ramp near Punt Bridge.	Central Coast Hwy	2	GCC			P41	$ 132,970		0	0	-1	0	0	0	1	0	0	0	0	1		1.5
W25	Sedimentary Processes	Works	Dredge in the Saratoga (Paddy's and Lintern) Channel(s) and around the boat ramps to permit better access.	Saratoga and Green Point	2	LPMA, GCC	NSW Maritime	R08, R09		$ 600,000		-1	1	-1	0	0	0	1	0	0	0	0	1		1.5
W105	Recreational Usage	Works	Extend Orana St boat ramp to permit access at low tide.	Green Point	2	GCC				$ 75,000		0	-1	-1	0	0	0	1	0	0	0	-1	1		0.5
W106	Recreational Usage	Works	Provide for regular removal of accumulated seagrass wrack from the beach opposite the Sailing Club at this popular recreational area.	Mason Pde and Dane Dr, Gosford	2	GCC				$ 132,425		0	0	-1	0	0	1	1	0	0	0	1	-1		-0.5
W12	Water and Sediment Quality	Works	Provide for ongoing maintenance of the opening(s) under the Brisbane Water Drive causeway to prevent siltation and maintain flushing.	Woy Woy	3	GCC		W11		$ 132,425		2	1	2	1	0	0	1	0	0	0	7	2		10
W04	Water and Sediment Quality	Works	Provide additional sediment traps for locations draining to Correa Bay. Sediment traps should target catchment inflows from the Bulls Hill Quarry and Garbage tip.	Correa Bay	3	GCC		W01, W22		$ 179,455		2	1	2	0	0	0	1	0	0	0	6	1		7.5
W07	Water and Sediment Quality	Works	Provide ongoing maintenance of existing sediment traps in locations draining to Horsfield Bay.	Horsfield Bay	3	GCC		W01		$ 63,564		2	1	2	0	0	0	1	0	0	0	6	1		7.5
W59	Foreshore Flooding/Inundation	Works	Restore flows to Woy Woy Creek by de-commissioning the dam at the former abattoir site.	Woy Woy Creek	3	GCC	DWE	W40		N/A		1	1	1	1	0	0	0	0	0	0	4	2		7
W11	Water and Sediment Quality	Works	Install an additional opening/culvert under the Brisbane Water Drive causeway with a view to increasing flushing of Woy Woy Inlet and Woy Woy Bay and promoting scouring of the adjacent navigational channels. This option will require detailed investigations to confirm the feasibility and long term sustainabilityprior to proceeding with implementation.	Woy Woy	3	GCC	RailCorp	W12		$ 500,000		2	2	1	1	0	0	1	0	0	0	7	0		7
R16	Sedimentary Processes	Research/Monitoring	Identify the cause of erosion under the bridge near Lara Street and outline measures to address this issue.	Park Bay	3	GCC		W34		$ 35,000		1	1	1	0	0	0	0	0	0	0	3	2		6
W40	Sedimentary Processes	Works	Restore flows to Woy Woy Creek by de-commissioning the dam at the former abattoir site with a view to providing for natural scouring of the creek channel.	Woy Woy	3	GCC		W59		$ 120,000		1	1	0	1	0	0	0	0	0	0	3	2		6

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W42	Sedimentary Processes	Works	Undertake foreshore stabilisation works to address erosion currently occurring near Goondi Close.	Horsfield Bay	3	GCC			W34	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W88	Recreational Usage	Works	Provide navigational markers for the following locations: - The sand bar in Correa Bay, and - The unmarked rock outcrop in Horsfield Bay.	Correa Bay, Horsfield Bay	3	NSW Maritime		W87	W88	$ 20,000		0	0	1	0	0	0	1	0	0	0	2	2		5
W21	Sedimentary Processes	Works	Dredge from the Correa Bay boat ramp to the entrance of Woy Woy Creek, to extend 300m up the creek channel, with a view to improving drainage and access at this location.	Woy Woy	3	LPMA, GCC	NSW Maritime	R08		$ 500,000		-1	1	1	1	0	0	1	0	0	0	3	1		4.5
W22	Sedimentary Processes	Works	Dredge from Bulls Hill to Correa Bay to remove sediment that has been deposited there in the last few years.	Woy Woy	3	LPMA, GCC		W04		$ 500,000		-1	1	1	1	0	0	1	0	0	0	3	1		4.5
W78	Habitat and Species Conservation	Works	Undertake program of weed removal in Horsfield Bay and Correa Bay foreshore reserves.	Horsfield Bay, Correa Bay	3	GCC	Volunteers	W73		N/A		0	-1	1	0	0	1	0	0	0	0	1	2		4
P37	Recreational Usage	Planning	Provide either a speed restriction or ban on water skiing in Waterfall Bay in order to minimise conflicts between houseboats and water skiers.	Waterfall Bay	3	NSW Maritime		C08, C09, P41		$ 68,267		0	0	1	0	0	0	1	0	0	0	2	1		3.5
W98	Recreational Usage	Works	Provide additional public open space areas incorporating walking tracks in the Woy Woy area (to the waterfall and through the former abattoir site).	Woy Woy	3	GCC		W82, W99		$ 461,880		0	-1	0	0	0	1	1	0	0	0	1	1		2.5
R35	Recreational Usage	Research/Monitoring	Investigate options for improving public access over the rail line to the foreshore adjacent to Railway Street.	Woy Woy	3	GCC	RailCorp			$ 50,000		0	0	-1	0	0	-1	1	0	0	0	-1	2		2
W61	Foreshore Flooding/Inundation	Works	Undertake to remove mangroves currently impeding flow out of the stormwater outlets located near the train station on Railway Street.	Woy Woy	3	GCC		W57	W58	$ 80,000	NSW Floodplain Management Program (pending outcome of Brisbane Water Floodplain Risk Management Study and Plan)	-1	1	-1	1	0	0	0	0	0	0	0	1		1.5
W118	Sedimentary Processes	Works	Dredge to improve navigation in Woy Woy Bay.	Woy Woy Bay	3	GCC	LPMA	R08		$ 200,000		-1	1	0	0	0	0	1	0	0	0	1	0		1
W20	Sedimentary Processes	Works	Dredge the sand bars in the channel between Blackwall Point and Allfield Road, Woy Woy, with a view to improving navigation.	Woy Woy	3	LPMA, GCC	NSW Maritime	R08		$ 360,000		-1	1	-2	0	0	0	1	0	0	0	-1	1		0.5
W99	Recreational Usage	Works	Acquire the former abattoir site for incorporation into Council's system of public reserves.	Woy Woy	3	GCC	LPMA	W98		$ 3,500,000		-4	0	1	0	0	0	1	0	0	0	-2	1		-0.5
W35	Sedimentary Processes	Works	Design and construct appropriate sediment control works to address sediment accretion issues at St Hubert's Island.	St Hubert's Island	4	GCC		P08, R13, W19		$ 558,910		2	2	3	0	0	0	0	0	0	0	7	2		10
W46	Sedimentary Processes	Works	Investigate the cause of erosion around the Blackwall Point boat ramp and develop measures to address this issue. Any necessary repairs to stabilise the foreshore and the adjacent roadway should be undertaken.	Blackwall	4	GCC		W09, W34		$ 255,940		1	1	1	0	0	0	1	0	0	0	4	2		7
W45	Sedimentary Processes	Works	Undertake foreshore stabilisation works to address erosion currently occurring in Palermo Reserve, Empire Bay Drive.	Daleys Point	4	GCC			W34	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W49	Sedimentary Processes	Works	Implement foreshore stabilisation works to prevent further erosion of the shoreline near Rip Road reserve.	Blackwall	4	GCC	Volunteers		W34	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W13	Water and Sediment Quality	Works	Develop and implement measures to address stormwater quality issues associated with runoff from fire trails on Blackwall Mountain.	Blackwall	4	GCC	DECCW	W01, R24		$ 138,564		1	2	1	0	0	0	0	0	0	0	4	1		5.5
P08	Sedimentary Processes	Planning	Review and revise DCP 145 Boating Facilities in St Hubert's Island Canals to ensure consistency with the goals objectives of the Management Study and Plan. In particular, explicit consideration of sedimentary processes should form part of the assessment process for all development applications.	St Hubert's Island	4	GCC		W19, W35	R13	$ 15,000		0	1	2	0	0	0	-1	0	0	0	2	2		5
W43	Sedimentary Processes	Works	Develop and implement a long term solution to replace the currently failing seawall in Lions Memorial Park on Brick Wharf Road. Any option identified should wherever possible incorporate environmentally friendly features.	Woy Woy	4	GCC	DECCW	P62, W80	W34	$ 658,910		1	1	1	0	0	1	1	0	0	0	5	0		5
W44	Sedimentary Processes	Works	Replace collapsed stormwater drain running between the two ovals in Austin Butler Reserve and remove accreted sediments. There is a preference for the use of a natural vegetated swale and/or small wetland.	Woy Woy	4	GCC				$ 100,000		1	1	-1	1	0	0	1	0	0	0	3	1		4.5
W62	Foreshore Flooding/Inundation	Works	Investigate and implement options to improve flow from the stormwater outlets located in the Lions Memorial Park on Brick Wharf Road, to include a program of ongoing weed removal. A fish friendly tide gate/flap should also be considered to prevent estuarine ingress when the outlet is inundated.	Woy Woy	4	GCC	Volunteers	W43, W80		$ 205,940		1	0	-1	1	0	0	0	0	0	0	1	2		4
W80	Habitat and Species Conservation	Works	Undertake program of weed removal in Lions Memorial Park on Brick Wharf Road, around the boat ramp in particular.	Woy Woy	4	GCC	Volunteers	W73		N/A		0	-1	1	0	0	1	0	0	0	0	1	2		4
W109	Recreational Usage	Works	Investigate and implement suitable options for improving drainage of the oval located near Willaroo Road.	Saratoga	4	GCC				$ 355,940		0	0	0	1	0	0	1	0	0	0	2	1		3.5
W19	Sedimentary Processes	Works	Undertake an ongoing program of maintenance to restore the drainage canals of St Hubert's Island to their original design criteria.	St Hubert's Island	4	GCC		R08, R09		$ 2,074,252		-1	2	-2	0	0	0	1	0	0	0	0	2		3
W117	Sedimentary Processes	Works	Dredge to improve navigation in Woy Woy Channel near Pelican Island.	Woy Woy	4	GCC	LPMA	R08, R09	P07	$ 647,276		-1	1	0	0	0	0	1	0	0	0	1	1		2.5
W50	Sedimentary Processes	Works	Undertake minor dredging works to improve access to the Centennial Street boat ramp.	Saratoga	4	GCC				$ 80,000		-1	1	-1	0	0	0	1	0	0	0	0	1		1.5
W108	Recreational Usage	Works	Undertake review of need requirements for the tidal baths located near Brisbane Water Drive. An upgrade from netting to stainless steel bars should be considered.	Woy Woy	4	GCC			P41	$ 355,940		0	-1	-1	0	0	0	1	0	0	0	-1	-1		-2.5
P27	Habitat and Species Conservation	Planning	Develop a Plan of Management to provide protection for the Green and Golden Bell Frog and the Bush Stone Curlew populations occurring in Davistown.	Davistown	5	GCC	University of Newcastle	E05, P23, P24		$ 55,000	Australian Bird Environment Foundation Grant	1	0	5	0	0	0	0	0	0	1	7	2		10
C03	Water and Sediment Quality	Compliance	Work with private land holders / tenants to improve stormwater management practices in the industrial estate near Hawke Street.	Kincumber	5	GCC	DECCW			$ 15,000		2	2	1	0	0	1	1	0	0	1	8	1		9.5
R13	Sedimentary Processes	Research/Monitoring	Audit foreshore structures such as boat ramps, seawalls and the like, in the canals of St Hubert's Island and identify those structures that are exacerbating erosion or accretion issues for other properties. Where feasible, require license holders for these structures to modify or retrofit problematic structures to mitigate these issues. Where possible, promote reinstatement of a natural vegetated shoreline. This may be achieved through the licensing/license renewal process.	St Hubert's Island	5	GCC	LPMA	C14, R31		$ 60,000		1	2	3	0	0	0	0	0	0	0	6	2		9
W47	Sedimentary Processes	Works	Seek to remediate scouring currently occurring behind the existing seawall in Illoura Reserve. This may necessitate replacement of the existing seawall with a new, environmentally friendly seawall structure. Consideration should also be directed to the principles of "Safety by Design" to manage vandalism.	Davistown	5	GCC		W48, W56	W34	$ 632,425		1	2	1	0	0	0	1	0	0	0	5	1		6.5
C06	Habitat and Species Conservation	Compliance	Investigate measures to address vandalism of regionally significant vegetation located in the reserve near Carrak Road. Measures may include the imposition of fines, education or fencing.	Kincumber	5	GCC		C05		$ 82,970		0	0	2	0	0	1	0	0	0	0	3	2		6
W48	Sedimentary Processes	Works	Implement foreshore stabilisation works to prevent further erosion of the Illoura Reserve foreshore between Lintern Street and 28 Molinya Road.	Davistown	5	GCC	Volunteers	W47, W56	W34	$ 132,970		1	1	1	0	0	0	1	0	0	0	4	1		5.5
W15	Water and Sediment Quality	Works	Seal the Hawke Street car park to prevent erosion into Kincumber Creek. The use of permeable pavement is recommended over impermeable surfaces.	Kincumber	5	GCC		W01, R26		$ 163,564		1	1	1	0	0	1	0	0	0	0	4	1		5.5

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W111	Recreational Usage	Works	Remove and dispose of disused boat trailer and floating pontoon (Hawke Street).	Kincumber	5	GCC	LPMA			$ 20,000		0	0	0	0	0	1	1	0	0	0	2	1		3.5
W110	Recreational Usage	Works	Provide a shared pedestrian pathway/cycleway in the reserve near Carrak Road to improve recreational access and link with other areas.	Kincumber	5	GCC		W82		$ 302,970		0	0	0	0	0	0	1	0	0	0	1	1		2.5
W116	Sedimentary Processes	Works	Dredge to improve navigation and access to boat ramps in Cockle Channel.	Davistown	5	GCC	LPMA	R08, R09	P07	$ 647,276		-1	1	0	0	0	0	1	0	0	0	1	1		2.5
P06	Sedimentary Processes	Planning	Develop an Entrance Management Policy for Brisbane Water to provide a strategic framework for the maintenance of navigation through the Estuary entrance.	Entrance	6	GCC	NSW Maritime	R09, R27, W18, W28	P07	$ 71,485		0	5	2	0	-1	0	4	0	2	2	14	2		17
W29	Sedimentary Processes	Works	Replace the existing shoreline protection works (boulders) with a stepped, vegetated dune that provides for public access and amenity.	Ettalong Beach	6	GCC	DECCW, LPMA	P10, P12, W28, W55, W97, W112	P42, R11	$ 1,358,910	NSW Coastal Management Program	0	3	2	2	1	3	3	1	0	0	15	1		16.5
P25	Habitat and Species Conservation	Planning	For those areas of seagrass at Ettalong shown to be important for fish recruitment, develop a strategy to protect and conserve them, including an education program for beach users, and undertake regular monitoring to assess the condition of the seagrass.	Ettalong	6	GCC	CMA, DII - Fisheries, CCCEN	E01, P09, P18, P20, P21, R20, R23, W65		$ 362,820		1	0	5	0	0	0	2	2	0	2	12	2		15
W26	Sedimentary Processes	Works	Rehabilitate the eroding foreshores on the eastern shores of Hardy's Bay with natural vegetation typical of that naturally occurring in the area.	Eastern shores of Hardy's Bay	6	GCC	Volunteers	E09, P49		$ 20,000		2	4	3	2	0	2	0	0	0	0	13	1		14.5
R11	Sedimentary Processes	Research/Monitoring	Assess options for shoreline protection works that will seek to address the long-term erosion issues at Ettalong Beach.	Ettalong Beach	6	GCC	LPMA	P12, P43, W28, W29	P42	$ 80,000	NSW Coastal Management Program	0	3	2	2	1	0	3	1	0	0	12	1		13.5
P12	Sedimentary Processes	Planning	Develop an Emergency Action Plan for Ettalong Beach in accordance with NSW Coastal Policy. The aim of the Plan should be to establish a framework for managing storm erosion events in a strategic fashion that considers public safety, public access and amenity, and ecological concerns. This option is dependent upon information provided in a Coastal Hazard Study.	Ettalong	6	GCC	DECCW	R11, W17, W28, W29, W55, W97, W112	P42, P43	$ 130,000	NSW Coastal Management Program	0	3	0	3	0	1	3	0	0	0	10	2		13
W18	Sedimentary Processes	Works	Dredge the navigation channel up to 50,000m3 in the Estuary entrance as a priority.	Entrance	6	LPMA, GCC	NSW Maritime	R08, R09, W28	P06	$ 2,439,102		-1	4	0	0	-1	0	4	3	0	0	9	2		12
W28	Sedimentary Processes	Works	Undertake beach re-nourishment works at Ettalong Beach. The use of sand dredged from the Ettalong Shoals should be considered for this option.	Ettalong Beach	6	GCC	LPMA	P10, P12, W29, W55, W97, W112	P42, R11	$ 1,374,252		-1	4	0	0	-1	0	4	3	0	0	9	2		12
R27	Cultural Heritage	Research/Monitoring	Identify the likely location and condition of ship wrecks near the old bar via a maritime archaeological survey.	Entrance	6	DoP	LPMA	W18		$ 80,000		0	2	0	0	5	0	1	0	0	0	8	2		11
W33	Sedimentary Processes	Works	Reinstate a vegetated, sandy shoreline at Pretty Beach similar to that present prior to the construction of Pretty Beach Road. The use of mangroves for revegetation works is discouraged due to their potential to outcompete and displace saltmarsh.	Pretty Beach	6	GCC	Volunteers	P49, W31, W32		$ 288,564		1	2	2	0	0	2	1	0	0	0	8	2		11
P42	Recreational Usage	Planning	Update the existing Ettalong Beach Plan of Management in line with the findings of the Brisbane Water Estuary Processes Study and in line with the objectives of the Estuary Management Plan.	Ettalong	6	GCC		P12, R11, W28, W29, W97		$ 60,000		0	1	1	1	1	1	1	1	1	0	8	1		9.5
W39	Sedimentary Processes	Works	Rehabilitate eroded foreshore near 29 Araluen Drive, Killcare.	Killcare	6	GCC			W34	$ 80,000		1	1	2	1	0	0	1	0	0	0	6	2		9
W06	Water and Sediment Quality	Works	Install and maintain as required sediment traps targeting stormwater flows draining from the escarpment at Hardy's Bay.	Hardy's Bay	6	GCC		W01		$ 163,564		2	1	2	0	0	0	1	0	0	0	6	1		7.5
W30	Sedimentary Processes	Works	Remove the sandstone and cement abutments from the Pretty Beach jetty and adjacent to the pool.	Pretty Beach	6	GCC		P39, W31		$ 500,000		0	1	1	0	0	1	1	0	0	0	4	2		7
W55	Sedimentary Processes	Works	Identify the cause of foreshore erosion in Lance Webb Reserve and develop and implement measures to stabilise the foreshore.	Ettalong	6	GCC		W97, W112	P42, R11	$ 279,455	NSW Coastal Management Program	1	1	1	0	0	0	1	0	0	0	4	2		7
W17	Water and Sediment Quality	Works	Implement a program of maintenance to address the accumulation of litter in the open drain near Beach Street. Long term management of this issue should also be considered, for example, public education and/or the implementation of additional gross pollutant traps.	Ettalong	6	GCC		C15, W01		$ 138,564		1	0	1	0	0	1	1	0	0	1	5	1		6.5
W75	Habitat and Species Conservation	Works	Where possible, re-introduce native cockles and other shellfish to suitable depleted habitats (such as seagrass beds in Hardy's Bay, Pretty Beach and Riley's Bay).	Hardy's Bay, Pretty Beach and Riley's Bay	6	DII - Fisheries				$ 173,910		1	0	2	0	0	0	0	0	0	0	3	2		6
P10	Sedimentary Processes	Planning	Develop planning controls specific to the foreshore running between Ettalong and Booker Bay to limit activities in the active coastal zone to those compatible with the observed cycles of sediment accretion and erosion.	East of Schnapper Road, Ettalong	6	GCC	DECCW	P12, P42, P52, R11, W28, W29, W55	P35, P43, P44	$ 30,000		0	2	0	3	1	0	-1	-2	0	0	3	2		6
R17	Sedimentary Processes	Research/Monitoring	Investigate options for implementation to address the erosion along Hardy's Bay Parade.	Killcare	6	GCC		W34		$ 299,455		1	1	1	0	0	0	0	0	0	0	3	2		6
P39	Recreational Usage	Planning	Assess options for relocation of the Pretty Beach pool such that it will be suitable for swimming under all tidal conditions and is not subject to sediment build-up.	Pretty Beach	6	GCC		W30-32		$ 55,000		1	1	0	1	0	0	1	0	0	0	4	1		5.5
W14	Water and Sediment Quality	Works	Develop and implement measures to address stormwater quality issues associated with runoff from the access road and fire trails near Fisherman's Parade.	Daleys Point	6	GCC	DECCW	W01, R25		$ 138,564		1	2	1	0	0	0	0	0	0	0	4	1		5.5
W112	Recreational Usage	Works	Identify measures to improve public access to Lance Webb Reserve and the beach in this location.	Ettalong	6	GCC		W82		$ 50,000		0	0	1	0	0	0	1	0	0	0	2	2		5
R23	Habitat and Species Conservation	Research/Monitoring	Audit and assess the route used by the Palm Beach - Ettalong ferry. Where possible, the navigation route used by the ferry should avoid seagrass beds in this location.	Ettalong	6	NSW Maritime	DII - Fisheries	C08, R34		$ 15,000		0	2	2	0	0	0	-1	0	0	0	3	1		4.5
R34	Recreational Usage	Research/Monitoring	Audit and assess the route used by the Palm Beach - Ettalong ferry. Where possible, the navigation route used by the ferry should avoid popular bathing spots in this location.	Ettalong	6	NSW Maritime	GCC	C08, R23		$ 20,000		0	1	-2	0	0	0	2	0	0	0	1	2		4
W119	Sedimentary Processes	Works	Extend dredging of the Entrance Reach further upstream past Kourung Gourung Point between Ettalong Beach and Pretty Beach with a view to improving navigation.	Entrance	6	GCC	LPMA	R08, R09	P06, P07	$ 1,559,401		-1	2	-1	0	-1	0	2	0	0	0	1	2		4
W97	Recreational Usage	Works	Provide additional access points to Ettalong Beach from Lance Webb Reserve.	Ettalong	6	GCC		P10, P12, W29, W55, W97	P42, R11	$ 55,000		0	-1	1	0	0	0	2	0	0	0	2	1		3.5
W120	Sedimentary Processes	Works	Dredge to improve access to the boat pump-out and other facilities in Hardy's Bay. The dredging should be sufficient to permit access over the full tidal cycle.	Hardy's Bay	6	GCC	LPMA	R08		$ 200,000		0	1	0	0	0	0	1	0	0	0	2	1		3.5
W23	Sedimentary Processes	Works	Deepen and widen the outlets of Mudflat and RSL Creeks in Hardy's Bay so that both creeks restore tidal flushing. The efficacy of this option in improving flushing should be assessed prior to undertaking the works.	Mudflat and RSL Creeks	6	LPMA, GCC		R07, W06, W27, W34		$ 160,000		-1	1	1	1	0	0	0	0	0	0	2	1		3.5
W54	Sedimentary Processes	Works	Investigate and implement measures to address the eroding seawall located near Araluen Drive on the southern side of Hardy's Bay. Preferred options include re-establishment of native vegetation or an environmentally friendly seawall.	Hardy's Bay	6	GCC			W34	$ 425,940		0	1	1	0	0	0	0	0	0	0	2	1		3.5
W31	Sedimentary Processes	Works	Remove accreted sediments from the eastern shoreline along Pretty Beach, including those that have built up in the swimming pool.	Pretty Beach	6	GCC		P39, W30, W32		$ 264,850		-1	1	2	0	0	0	1	0	0	0	3	0		3
W32	Sedimentary Processes	Works	Dredge sediments around the boat launching pontoon at Pretty Beach to enable boats to tie up on both sides of the pontoon.	Pretty Beach	6	GCC		W31, W33		$ 1,326,282		-1	1	2	0	0	0	1	0	0	0	3	0		3

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W57	Foreshore Flooding/Inundation	Works	Remove the mangroves from Turo Creek to permit the passage of flood flows from the catchment.	Pretty Beach	6	GCC	Volunteers	W61	W58	$ 97,970	NSW Floodplain Management Program (pending outcome of Brisbane Water Floodplain Risk Management Study and Plan)	-1	1	-1	1	0	0	0	0	0	0	0	1		1.5
W121	Sedimentary Processes		Investigate options to address access and amenity issues associated with the blockage of the entrance to Riley's Bay and sediment accretion in this area.	Riley's Bay	6	GCC	LPMA	R08		$ 50,000		-1	1	0	0	0	0	1	0	0	0	1	0		1
W24	Sedimentary Processes	Works	Deepen and widen the entrance to Hardy's Bay to permit greater tidal flushing. The efficacy of this option in improving flushing should be assessed prior to undertaking the works. In addition, the environmental aspects must also be considered.	Hardy's Bay	6	LPMA, GCC		R08		$ 500,000		-1	2	-2	0	0	0	1	0	0	0	0	0		0
E04	Information, Communications and Education	Education	Develop a public awareness and education program focusing specifically on the biodiversity and ecological value of saltmarsh habitats.	LGA-wide	All	GCC	CMA, DECCW	E03, E05, E06, E09, P30, P49, R19, W68, W70, W71, W76	R20, R22	N/A		1	1	4	1	0	0	0	0	0	3	10	1		11.5
P23	Habitat and Species Conservation	Planning	Develop a conservation strategy for the birds of Brisbane Water Estuary that addresses the main issues of disturbance by pedestrians, dog-walkers and watercraft, predation by feral and domestic animals and habitat loss/degradation.	Waterway-wide/Catchment-wide	All	GCC	CMA, DECCW, local bird watching clubs	E05, P24, P27		$ 135,940	Australian Bird Environment Foundation Grant	0	0	5	0	0	0	1	0	0	0	6	2		9
P22	Habitat and Species Conservation	Planning	Provide protection for those areas identified in the Estuary Processes Study as being important for biological connectivity in the Estuary.	Waterway-wide/Catchment-wide	All	GCC	DII - Fisheries, DECCW	P26, P38		$ 30,000		0	0	5	0	0	0	0	0	0	0	5	2		8
R12	Sedimentary Processes	Research/Monitoring	Examine the feasibility of regularly removing accumulated sediments from Fagan's Bay and Woy Woy Bay with a view to using these areas as sediment traps to prevent sediment accretion in the main waterbody of the Estuary.	Fagan's Bay, Woy Woy Bay	1, 3	GCC	LPMA			$ 42,000		-1	1	3	0	0	0	0	1	0	0	4	-1		2.5
W100	Recreational Usage	Works	Progress towards removal of oyster leases in Lintern Channel, west of Empire Bay, Riley's Island and Pelican Island.	Lintern Chanel, Empire Bay, Pelican Island	2, 4	DII - Fisheries		P17, W74		$ 60,000		0	1	3	0	-1	2	0	-2	0	0	3	0		3
W05	Water and Sediment Quality	Works	Advertise and provide signage for boat pump-out facilities.	Gosford, Hardy's Bay	2, 6	NSW Maritime		E11, P55, W02, W81		$ 70,470		3	0	2	0	0	0	2	0	0	0	7	0		7
P24	Habitat and Species Conservation	Planning	Develop conservation and education strategies for the Bush Stone-Curlew of Brisbane Water.	Kincumber Broadwater, Woy Woy	3, 5	GCC	CMA, DECCW, local bird watching clubs	P23, P27, C10		$ 135,940	Australian Bird Environment Foundation Grant	0	0	3	0	0	0	1	0	0	2	6	2		9
R37	Governance	Research/Monitoring	Design an Estuary Monitoring Plan to include elements of the physical, social and biological environment to evaluate the success in meeting the objectives and goals outlined in the Estuary Management Plan. The monitoring program should be designed with consideration of the unique characteristics of the Estuary and support the recommendations of the Brisbane Water Estuary Process Study. Consideration should be given to including monitoring for climate change impacts.	Catchment-wide/Waterway-wide	All	GCC		R37, R40		$ 607,671		4	4	4	3	2	1	1	0	5	5	29	2		32
P41	Recreational Usage	Planning	Prepare a Brisbane Water Estuary Users Plan which addresses such issues as equity of access, boat storage, conflicts of usage, mooring types and caps, number and type of public access points (wharves and jetties), coverage and consistency of foreshore Plans of Management with priority areas identified for new Plans of Management, estimation of an estuary carrying capacity with respect to development intensity, fishing/fisheries and boating.	Estuary Foreshores/Waterway-wide	All	GCC		C12, P37, P55, R33, W81	R31, R32	$ 60,000		2	2	5	0	0	2	5	5	0	5	26	2		29
R36	Governance	Research/Monitoring	Establish an annual reporting mechanism to communicate progress towards achieving the goals and objectives of the Management Plan, with specific reference to any actions or monitoring undertaken during that year, as well as the effectiveness of implementation of the Plan based on comparison with specific performance targets/indicators. The annual report should be distributed amongst Council, the CEMC and the community to ensure that all parties are informed of the Plan.	Catchment-wide/Waterway-wide	All	GCC		R40	R38	$ 158,910		3	3	3	3	2	1	1	0	5	5	26	1		27.5
P43	Foreshore Development	Planning	Prepare a Sea Level Rise Study that will deliver land use zoning and development controls for the Estuary that are based on the current IPCC projections of 0.91m sea level rise by 2100. The preparation of this study should be closely linked to the Brisbane Water Foreshore Flood Plain Risk Management Study & Plan, anticipated to be drafted by 2011.	Estuary Foreshores	All	GCC	DECCW	P10, P15, P44, P45, P51, P52, P54		$ 45,000		0	3	2	5	4	0	-1	3	0	5	21	2		24
P53	Commercial Development	Planning	Promote the Brisbane Water Estuary for eco-tourism and support relevant local commercial development in this area.	Estuary Foreshores/Waterway-wide	All	GCC	LPMA, Central Coast Tourism, Gosford Chamber of	P22, P38, P54, P55,	P54	$ 1,359,401		0	0	5	0	4	2	5	5	0	0	21	1		22.5
R38	Governance	Research/Monitoring	Research possible sources of funding and secure ongoing funding for implementation of the Plan. It is anticipated that responsibility and funding for these studies/plans may be shared across State, Federal and local government agencies.	Catchment-wide/Waterway-wide	All	GCC		R38		N/A		2	3	3	3	3	1	1	0	5	0	21	1		22.5
W01	Water and Sediment Quality	Works	Investigate options for implementing catchment based WSUD features in the catchment in order to manage stormwater quality and quantity, with a priority focus on the Narara and Erina Creek catchments, followed by Kincumber Creek catchment.	Catchment-wide	All	GCC		P05, R04-R06, R24, W04, W06, W07, W10, W13, W14		$ 748,611		5	4	5	0	0	1	2	1	0	0	18	2		21
P54	Commercial Development	Planning	Promote the sustainable commercial development of the Estuary and its foreshores in accordance with Council's Corporate Strategy and the principles of Ecologically Sustainable Development.	Catchment-wide/Waterway-wide	All	GCC	LPMA	P53, P55, P56, P57		$ 582,671		-1	-1	4	-1	4	3	4	5	0	0	17	2		20
E08	Information, Communications and Education	Education	Give consideration to methods of detecting and informing the community of changes to sea levels and other potential climate change impacts. These methods should not result in a sense of panic or alarm, instead they should empower the community to act in a well considered and informed manner and where possible, encourage the community to become engaged in Council's decision making processes. The information provided to the public should be supported by research presented by the IPCC and the State/Federal government.	LGA-wide	All	GCC	DECCW, CMA		P43	$ 25,000	National Natural Disaster Mitigation Program	1	2	0	5	0	0	0	4	0	5	17	2		20
P04	Water and Sediment Quality	Planning	Review and revise DCP 165 - Water Cycle Management to reflect current best practice.	LGA-wide	All	GCC		C02, C13, P43, W58		$ 40,000		4	2	4	4	0	0	2	1	0	0	17	2		20
R02	Water and Sediment Quality	Research/Monitoring	Ensure ongoing monitoring of the water and sediment quality of the Brisbane Water Estuary for the purposes of recreational usage and ecological health.	Waterway-wide	All	GCC	CMA	R37, R38, R40	R01	$ 2,330,683		5	0	3	0	0	0	4	1	1	3	17	2		20

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W34	Sedimentary Processes	Works	Identify locations of bank erosion along creekline corridors and the Estuary foreshore. Design and implement remediation measures to address these issues, with re-establishment of native vegetation being the preferred option where feasible. Reference should be made to the shoreline assessment provided in Appendix H of the Brisbane Water Estuary Processes Study.	Erina Creek, Narara Creek, Woy Woy Creek, Hardy's Bay and Kincumber Creek as a priority	All	GCC	DWE, DECCW	P13, P14, R10, R17, W38, W41, W42, W45, W46, W48, W49, W53, W55		$ 2,053,952		3	4	4	1	1	1	2	0	0	0	16	2		19
P58	Governance	Planning	Ensure the ongoing involvement of the Coasts and Estuaries Management Committee in the implementation of the Plan. Representation from the community, Council and from all the agencies responsible for implementation of the Plan should be maintained at all times.	Catchment-wide/Waterway-wide	All	GCC	DECCW	P36-P38, W113		N/A		2	2	2	2	1	1	1	0	4	2	17	1		18.5
P59	Governance	Planning	Develop a Vision Statement for the Brisbane Water Estuary consistent with the goals and objectives of the Plan.	Catchment-wide/Waterway-wide	All	GCC		P36-P38, W114		$ 5,000		0	0	3	0	1	1	1	1	5	5	17	1		18.5
R24	Habitat and Species Conservation	Research/Monitoring	Investigate the use of constructed wetlands, sediment, and detention basins and other WSUD options to minimise the effect of freshwater and sediment inflows, with particular reference to areas of high biodiversity value around entrances to creeks. Consideration should be given to both current and future meteorological conditions.	Catchment-wide	All	GCC	CMA	W01		N/A		3	4	3	5	0	0	2	0	0	0	17	1		18.5
R26	Habitat and Species Conservation	Research/Monitoring	Develop a research partnership with universities to continue the scientific focus on Brisbane Water Estuary and support this with annual research grants.	LGA-wide	All	GCC	Universities	E06, P19-P21, P27, P38		$ 453,761	Australian Research Council Grants	2	2	3	1	1	0	0	2	1	5	17	1		18.5
P15	Habitat and Species Conservation	Planning	Re-assess existing zoning and tenure of foreshore land with a view to providing for a range of human usages (recreational and commercial), as well as environmental protection, with due consideration of the potential impacts of climate change.	Estuary Foreshores	All	LPMA	GCC	P16, P44-P45, P48-P52, W60, W84	W34	$ 45,000		0	2	3	2	2	2	3	2	0	0	16	1		17.5
R39	Information, Communications and Education	Research/Monitoring	Develop and maintain a database of all environmental and ecological data available for the Brisbane Water Estuary with a view to providing a comparison between present and historic Estuary conditions. This database should be regularly updated with the results of any monitoring undertaken. Long term trends should be identified and this information communicated directly to the public on a regular basis.	Catchment/Waterway-wide	All	GCC	CMA, DECCW	R38, R04		$ 152,425		3	3	3	3	0	0	0	0	0	4	16	1		17.5
E09	Information, Communications and Education	Education	Provide foreshore property owners with information/guidelines about what constitutes good and bad practice with respect to foreshore management (e.g. limits of mowing, stabilisation works, etc.).	Foreshore Property Owners	All	GCC	LPMA	C02, C05, C14, E10, P11, P14, P44-P50		$ 109,455		2	2	3	3	0	1	0	0	0	3	14	2		17
P01	Water and Sediment Quality	Planning	Provide for the development, implementation and regular re-assessment of Riparian Zone and Bank Management Plans for the major tributaries draining into the Estuary, including Narara Creek, Erina Creek, Kincumber Creek (Riparian Plan already in place), Woy Woy Creek and Ettalong Creek.	Catchment-wide	All	GCC	DWE	P13, W34, W53		$ 1,574,252		4	3	4	1	0	2	0	0	0	0	14	2		17
C13	Foreshore Development	Compliance	Provide additional resources for enforcement of compliance with foreshore development controls.	LGA-wide	All	GCC		C02, C14		$ 794,551		2	3	3	3	1	1	0	0	0	2	15	1		16.5
E07	Information, Communications and Education	Education	Establish a 'Clean Up Brisbane Water Day' with the dual objectives of removing rubbish from the Estuary foreshores and waterways, and of educating the public about the Estuary.	Waterway-wide	All	GCC	NSW Maritime, DECCW	C15, E02, E11, R05, W91, W92, W93		$ 579,701		3	2	4	0	0	2	0	0	0	4	15	1		16.5
P60	Information, Communications and Education	Planning	Ensure that climate change considerations are incorporated into all relevant Plans of Management for locations around the Estuary.	LGA-wide	All	GCC	DECCW, CMA	E8, P42, W60	P43	$ 55,000		0	0	2	4	4	0	0	0	0	3	13	2		16
P07	Sedimentary Processes	Planning	Based on our understanding of the ecological and physical processes operating within the Estuary, develop a channel layout for recreational and commercial boating usage which details current (and potential future) channel widths and depths to provide users of Brisbane Water with certainty while acknowledging the limitations of the Estuary. The channel layout should take into consideration environmental impacts and address the natural rates of sedimentary accretion in those locations.	Waterway-wide	All	GCC, LPMA	NSW Maritime	P06, R09, W18-W20, W25		$ 142,376		0	4	3	0	0	0	4	1	2	2	16	0		16
R06	Water and Sediment Quality	Research/Monitoring	Undertake ongoing monitoring and maintenance of Council owned stormwater quality improvement devices.	Catchment-wide	All	GCC		R02, R04, R05		N/A		5	2	3	1	0	0	2	0	0	0	13	2		16
P45	Foreshore Development	Planning	Undertake a review of the existing foreshore development policies and plans for the Gosford LGA and assess the need to amend development controls to provide for controlled, sustainable development of the foreshore.	LGA-wide	All	GCC		P08, P09, P10, P29, P30, P54 , W82	P43	$ 60,000		1	4	3	4	1	3	0	-2	0	0	14	1		15.5
P49	Foreshore Development	Planning	Develop guidelines (or compile existing guidelines where available) for foreshore stabilisation via the establishment of locally native estuarine plant species. The guidelines should provide details of the benefits of soft stabilisation works, advice on the species to be used and how to establish plantings. Seedlings may be cultivated at Council's nursery for supply to interested parties.	LGA-wide	All	GCC	CMA, DECCW	W34, W41, W42, W45, W48, W49, W104		$ 559,701		2	5	4	2	0	0	0	0	0	2	15	0		15
P50	Foreshore Development	Planning	Review D6.47 - Setback Policy: Creeks, Rivers and Lagoons. The review should in the first instance widen the definition of applicable waterbodies to incorporate 'estuaries', and in the second instance be re-assessed to incorporate the likely impacts of climate change. In particular, the setbacks applied should be re-assessed to take into account processes relating to both catchment flooding and foreshore inundation.	LGA-wide	All	GCC		P44	P43	$ 15,000		0	4	3	5	0	0	0	0	0	0	12	2		15
P28	Habitat and Species Conservation	Planning	Provide adequate resources within Council to provide for ongoing management of Bushcare volunteers.	LGA-wide	All	GCC		W71, W73, W76, W78, W80		$ 847,521		1	1	5	0	0	1	1	0	0	3	12	2		15
R31	Recreational Usage	Research/Monitoring	Conduct an audit of existing land-based and water-based infrastructure for boating (e.g. picnic tables, playgrounds, BBQs, jetties, boat ramps, dinghy storage areas, moorings, trailer parking areas, etc.) focusing on: - Patterns in patronage/usage, - Condition and maintenance requirements, - Characterisation of neighbouring land uses, - Proximity to key habitat, heritage items and other environmentally sensitive areas, - Proximity to key locations (e.g. pump out stations, marinas, popular fishing spots, etc.), and - Safety. Based on the outcome of the audit, assess the need to upgrade, maintain or de-commission existing infrastructure.	Estuary Foreshores/Waterway-wide	All	GCC	LPMA, NSW Maritime	P34-P37, P41, P47, P55, R32, W69, W77, W81, W86, W93, W94-W96	P43	$ 120,000		1	1		1	1	1	5	2	0	0	12	2		15
W03	Water and Sediment Quality	Works	Provide for continued implementation of Council's Sewerage Enhancement Program and associated capital investments.	Catchment-wide	All	GCC				N/A		4	0	4	0	0	0	4	1	0	0	13	1		14.5
C01	Water and Sediment Quality	Compliance	Establish a program of auditing to ensure best management practices for marinas around Brisbane Water Estuary. DECCW's brochure Environmental Action for Marinas, Boatsheds and Slipways should be provided to marine operators.	All marinas	All	DECCW, NSW Maritime				$ 337,820		3	2	3	0	0	1	3	0	0	2	14	0		14

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R01	Water and Sediment Quality	Research/Monitoring	Conduct a review of the design and methodology employed in the existing water quality monitoring program. Ideally the program should be a comprehensive, scientifically rigorous and ongoing program of water and sediment quality monitoring for the Brisbane Water Estuary, incorporating dry weather and event monitoring of both the tributary mouths and main waterbody. Sampling in the main waterbodies should incorporate vertical profiling.	Catchment/Waterway-wide	All	GCC	CMA	R37, R38, R40		$ 35,000		4	0	3	0	0	0	3	0	0	1	11	2		14
W71	Habitat and Species Conservation	Works	Where appropriate, rehabilitate saltmarsh habitats, with saltmarshes at Saratoga, Empire Bay, Davistown and Riley's Island addressed as a priority.	Saratoga, Empire Bay, Davistown and Riley's Island	All	GCC	DECCW, CMA, Bushcare Volunteers	W69, W70		$ 218,910	Caring for Our Country Grant	2	3	5	1	0	1	0	0	0	0	12	1		13.5
W84	Recreational Usage	Works	Provide boardwalks at sensitive foreshore locations to permit public access.	Estuary Foreshores	All	GCC		P50-P52, W94	W81	$ 1,079,401		2	1	2	1	1	2	3	0	0	0	12	1		13.5
R10	Sedimentary Processes	Research/Monitoring	Conduct a condition assessment of existing stormwater outlets draining into the Estuary focusing on assessing impacts on natural sedimentary	All foreshore areas	All	GCC		W27, W36, W51, W61-		$ 80,000		3	3	3	3	0	0	0	0	0	0	12	1		13.5
R22	Habitat and Species Conservation	Research/Monitoring	Monitor the extent and condition of riparian, foreshore and aquatic vegetation around the Brisbane Water Estuary. Trends in vegetation condition and extent should be reported annually.	Waterway-wide/Catchment-wide	All	GCC	CMA, DII - Fisheries	R20, R36, R37		$ 648,141		0	1	4	1	0	1	0	0	0	3	10	2		13
E06	Information, Communications and Education	Education	Develop public awareness and education programs about the biodiversity of Brisbane Water, the important underlying ecological processes, and their relationships with human uses of the Estuary. The programs should focus on locations of high conservation value as a priority.	LGA-wide	All	GCC	University of Newcastle, Central Coast Marine Discovery Centre	E03, E05, E07, P20, P21, P24, P25, P28	R20, R22	$ 364,850		1	0	4	0	0	0	0	0	0	5	10	2		13
R04	Water and Sediment Quality	Research/Monitoring	Audit the performance of existing stormwater quality improvement devices and assess the need for modifications.	Catchment-wide	All	GCC		R05, R24, W01		$ 32,000		3	3	4	0	0	0	0	0	0	0	10	2		13
C14	Foreshore Development	Compliance	Audit existing foreshore development (including property boundaries, fences and other structures, boat houses, boat ramps, jetties, etc.) and identify illegal or non-conforming development for retrospective enforcement of development controls. This should be undertaken in accordance with the Conditions of Consent and relevant policy in force at the time of Development Approval.	Estuary Foreshores	All	LPMA	GCC	C02, C13, P10, P11, P14, P44, P51, P52	R31	$ 90,000		1	3	1	2	1	1	0	0	0	2	11	1		12.5
P17	Habitat and Species Conservation	Planning	Develop an Estuary-wide strategy for the management of aquaculture.	Waterway-wide	All	DII - Fisheries	GCC	W74, W100		$ 63,307		2	0	3	0	0	1	-1	3	0	3	11	1		12.5
E02	Information, Communications and Education	Education	Label stormwater drain inlets in problematic areas "This drains to ……".	Catchment-wide	All	GCC		C15, E07, R05		$ 46,485		3	2	3	0	0	-1	0	0	0	4	11	1		12.5
W02	Water and Sediment Quality	Works	Install additional sewage pump-out facilities to reduce water pollution. These should be situated at locations accessible by a range of vessels.	Waterway-wide	All	NSW Maritime		E11, P55, W81		$ 629,701	NSW Maritime Better Boating Program (up to 50%)	4	0	3	0	0	0	4	0	0	0	11	1		12.5
P16	Habitat and Species Conservation	Planning	Investigate opportunities to purchase saltmarsh areas for incorporation into Council's reserve system in accordance with policy R0.15 - Acquisition of Wetlands.	Estuary Foreshores	All	GCC	LPMA	R19		$ 5,297,007		1	1	4	2	0	0	1	0	0	0	9	2		12
C08	Recreational Usage	Compliance	Enforce boating regulations (particularly speed restrictions and zoning of activities) within Brisbane Water.	Waterway-wide	All	NSW Maritime		E01, E11, E12, W05, C12, C16	C09	$ 529,701		2	3	1	0	0	0	3	0	0	3	12	0		12
P36	Recreational Usage	Planning	Review of policies relating to boating use of the Estuary with a view to providing a balance between recreational and ecological uses. The review should include an assessment of policies relating to: - Speed limits, - No wash areas, - Dinghy storage areas, - Moorings, and - Jetties.	Estuary Foreshores/Waterway-wide	All	GCC	NSW Maritime, LPMA, University of Newcastle	P08, P37, P41, P48, R31, R32		$ 35,000		2	2	2	0	0	0	3	0	0	0	9	2		12
P09	Sedimentary Processes	Planning	Implement tighter erosion and sedimentation controls to minimize risks to seagrass, with a priority for catchments adjacent to areas of seagrass of high value for species.	Catchment-wide	All	GCC	DII - Fisheries	C13, P18, P20, P21, P25, R20, W35		$ 264,850		2	3	4	0	0	0	0	0	0	0	9	2		12
R09	Sedimentary Processes	Research/Monitoring	Conduct ongoing monitoring (by survey) of key navigation channels, including: - Entrance Channel, - Paddy's Channel, - Lintern Channel, - Woy Woy Channel, - Wagstaff Channel, - Cockle Channel, and - Saratoga Channel.	Waterway-wide	All	NSW Maritime		P06, P07, W18-W25		$ 79,455		0	3	0	0	-1	0	4	3	0	0	9	2		12
C02	Water and Sediment Quality	Compliance	Provide additional resources for Council officers to undertake audits of properties to ensure enforcement of policies and conditions of consent relating to water quality during both the construction and operational phases.	Catchment-wide	All	GCC		C13, P04		$ 741,581		3	3	3	0	0	0	0	0	0	0	9	2		12
P48	Foreshore Development	Planning	Develop environmentally friendly design and construction guidelines for foreshore infrastructure such as jetties, boat ramps and foreshore protection works. This should include advice on retro-fitting existing structures to be more environmentally friendly. The guidelines should be made publicly available and distributed to all foreshore property owners. (Note: Seawalls addressed in DECCW's *Environmentally Friendly Seawalls Guidelines*).	LGA-wide	All	GCC	NSW Maritime, DECCW, DII - Fisheries	R11, W29, W38		$ 93,564		2	3	3	0	0	0	0	0	0	2	10	1		11.5
C04	Habitat and Species Conservation	Compliance	Ensure ongoing enforcement of fishing regulations.	Waterway-wide	All	DII - Fisheries		E01		$ 317,820		1	0	3	0	0	0	3	0	0	3	10	1		11.5
C05	Habitat and Species Conservation	Compliance	Ensure the ongoing enforcement of Council's Tree Vandalisation Policy. Reference should also be made to D6.44 Landscape and Vegetation Management Policy.	LGA-wide	All	GCC		C06		$ 264,850		1	1	2	1	1	2	0	0	0	2	10	1		11.5
P20	Habitat and Species Conservation	Planning	Develop a conservation and education strategy for seagrass beds that support the highest diversity and abundance of fish, for beds at Koolewong, Woy Woy Bay, Woy Woy Inlet, Saratoga, and Davistown.	Koolewong, Woy Woy Bay, Woy Woy Inlet, Saratoga, and Davistown	All	GCC	DII - Fisheries, University of Newcastle, Fishcare Volunteers	E01, P18, P21, P22, P25, R20, W65		$ 140,940		1	0	5	0	0	0	1	0	0	3	10	1		11.5
P38	Recreational Usage	Planning	Undertake a public consultation process for input into planning for protection of areas of the Estuary important for biodiversity, habitats and ecological processes.	LGA-wide	All	GCC	DII - Fisheries, DECCW, University of Newcastle	P17-P25, R25		$ 35,000		2	0	5	0	0	0	0	0	0	3	10	1		11.5
R33	Recreational Usage	Research/Monitoring	Survey recreational fishermen to characterise demand, target species, gear type, etc.	Waterway-wide	All	DII - Fisheries	GCC, Fishcare Volunteers	E13, R18		$ 55,000	Recreational Fishing Trust	0	0	3	0	0	0	4	3	0	0	10	1		11.5

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W83	Recreational Usage	Works	Identify priority, privately owned/managed parcels of foreshore land for acquisition and/or incorporation into publicly accessible foreshore land.	Estuary Foreshores	All	LPMA	GCC	P50-P52, W94	W81	$ 5,826,708		0	1	2	1	1	2	3	0	0	0	10	1		11.5
W86	Recreational Usage	Works	Provide paid, secure dinghy storage facilities at strategic locations around Brisbane Water Estuary. Suggested priority areas include Koolewong, around Gosford and Green Point.	Estuary Foreshores	All	GCC	NSW Maritime	C07	P35, P36	$ 355,940	NSW Maritime - Maritime Infrastructure Program	0	3	1	0	1	2	3	0	0	0	10	1		11.5
C15	Information, Communications and Education	Compliance	Enforce littering restrictions and undertake parallel education programs about littering.	LGA-wide	All	GCC		E02, E07, E11, R05, W91, W92, W93		$ 99,455	Butt Littering Trust	2	0	1	1	0	2	0	0	0	4	10	1		11.5
P31	Cultural Heritage	Planning	Provide ongoing protection for sites of significance for local Aboriginal people.	LGA-wide	All	DECCW	GCC	P29	WP28, W34	$ 476,731		0	0	0	2	5	1	0	0	0	0	8	2		11
W113	Governance	Works	Establish a new position of River-Keeper for Brisbane Water following the NSW Maritime model.	Waterway-wide	All	NSW Maritime	GCC, CMA, DECCW	P58, P59, R36-R38		$ 1,059,401		1	1	1	1	1	1	1	0	2	2	11	0		11
R21	Habitat and Species Conservation	Research/Monitoring	Revise SEPP14 boundaries based on latest wetland vegetation mapping.	LGA-wide	All	DoP	DII - Fisheries			$ 35,000		0	0	5	0	0	0	0	0	0	3	8	2		11
W69	Habitat and Species Conservation	Works	Review existing sea walls in Council's foreshore parks to investigate possibility of returning natural foreshore and/or use of alternative materials that will: a) Increase the number of ecological niches, and b) Increase dissipation of wave energy. Reference should be made to DECCW's Environmentally Friendly Seawalls guidelines.	Estuary Foreshores	All	GCC	LPMA, DECCW, CMA	R15, W36, W43, W47, W54	W56, W41, R48	$ 579,701		1	3	5	-1	-1	1	0	0	0	0	8	2		11
W91	Recreational Usage	Works	Provide bins and bags for the disposal of animal faeces by dog walkers.	Catchment-wide	All	GCC		C10, W89		$ 120,940		3	0	1	0	0	1	3	0	0	0	8	2		11
E11	Information, Communications and Education	Education	Conduct an education program for the boating community on: - Their responsibilities with respect to the disposal of ballast, sewage and rubbish, - The location of existing sewage pump-out and rubbish disposal facilities, and - How to safeguard against leaks and spills, and what to do if a leak or spill occurs.	LGA-wide	All	NSW Maritime		C08, C15, E12, P02, P46, P47, R23, R34, W05	P36, P41	$ 130,940		2	0	3	0	0	0	0	0	0	3	8	2		11
R28	Cultural Heritage	Research/Monitoring	Assess the potential impacts of climate change on heritage items located around the Estuary and along its foreshores.	Waterway-wide/Catchment-wide	All	DoP	GCC	R28	P43	$ 50,000	NSW DoP Heritage Grant	0	0	0	3	5	1	0	0	0	0	9	1		10.5
R18	Habitat and Species Conservation	Research/Monitoring	Conduct a survey of recreational fishing catches and analyse recreational fishing trends to characterise both the impact on the fish populations of Brisbane Water Estuary and the value of recreational fishing as a local industry.	Waterway-wide	All	DII - Fisheries	University of Newcastle, Fishcare Volunteers	E13, R18, R33		$ 55,000	Recreational Fishing Trust	0	0	2	0	0	0	3	4	0	0	9	1		10.5
P02	Water and Sediment Quality	Planning	Develop and implement a pollution response strategy to address major pollution events. Policy D1.02 - Oil Spillages in Navigable Waters should be updated accordingly.	Waterway-wide	All	GCC	DECCW, NSW Maritime	C01, E11		$ 25,000	National Natural Disaster Mitigation Program	2	0	5	0	0	0	2	0	0	0	9	1		10.5
R03	Water and Sediment Quality	Research/Monitoring	Calculate a nutrient budget for the Estuary to assess the potential for eutrophication of the more enclosed portions of the waterway. The analysis should assess current conditions and conditions under climate change scenarios. Reference should be made to the water quality modelling undertaken for the Estuary as a whole, as outlined in Appendix E of the Brisbane Water Estuary Processes Study.	Waterway-wide	All	DECCW	GCC	W11, W12, W24	R03	$ 20,000		4	0	4	0	0	0	1	0	0	0	9	1		10.5
C07	Recreational Usage	Compliance	Ensure enforcement of the requirement to use formal dinghy storage racks provided by Council. This should include the confiscation of improperly stored dinghies or fining of the owners.	Estuary Foreshores	All	GCC		W77	P35, W86	$ 264,850		0	2	1	0	2	2	3	0	0	0	10	0		10
E13	Information, Communications and Education	Education	Provide an education program for recreational fisherman aimed at encouraging the reporting of information via fishing surveys, gamefish tagging and the occurrence of *Caulerpa taxifolia* .	LGA-wide	All	DII - Fisheries	Fishcare Volunteers	C04, P41, R18		$ 172,425		0	0	3	0	0	0	1	1	0	2	7	2		10
W27	Sedimentary Processes	Works	Undertake regular maintenance to remove sediments from the outlets of stormwater drains, starting with Hardy's Bay.	Catchment-wide	All	GCC		R10, W01		$ 529,701		2	3	2	3	0	0	0	0	0	0	10	0		10
W08	Water and Sediment Quality	Works	Provide more regular street cleaning to capture rubbish before it makes its way into the waterways.	Catchment-wide	All	GCC		C15, W93		$ 370,790		3	0	2	0	0	1	1	0	0	0	7	2		10
W70	Habitat and Species Conservation	Works	Fence existing saltmarshes to prevent access by vehicles, bikes and domestic animals.	Estuary Foreshores	All	GCC	CMA, Bushcare Volunteers	W71		$ 408,910	Caring for Our Country Grant	1	3	4	1	0	-1	-1	0	0	1	8	1		9.5
E03	Information, Communications and Education	Education	Develop interpretive signage promoting the biodiversity and value of different key habitat types in the Brisbane Water Estuary, to be placed along publicly accessible foreshores. Signage should be provided at locations of high conservation value as a priority.	Publicly accessible foreshore	All	GCC		E04, E05, E08, P18-P25, P28, P53, R20-	E06, R39	$ 311,880		0	0	4	0	0	-2	2	0	0	4	8	1		9.5
P44	Foreshore Development	Planning	Develop a guiding policy regarding the water boundary determination for foreshore properties consistent with Clause 55N of the *Coastal Protection Act 1979* .	Estuary Foreshores	All	LPMA	GCC		P43	$ 20,000		1	4	0	4	0	0	-1	-2	0	0	6	2		9
P47	Foreshore Development	Planning	Enforce jetty sharing arrangements via the leasing mechanism such that each jetty services 2-3 properties. This will involve review of applications for new leases as well as license/lease renewals.	Waterway-wide	All	LPMA		P33, P46		$ 25,000		2	1	1	0	1	2	-1	0	0	0	6	2		9
P26	Habitat and Species Conservation	Planning	Re-zone ecologically sensitive portions of the Estuary waterbody W2 - Environmental Protection under Council's forthcoming LEP.	Waterway-wide	All	GCC	DoP	E05, P24		$ 15,000		3	2	4	0	0	1	-3	-3	0	2	6	2		9
R19	Habitat and Species Conservation	Research/Monitoring	Investigate options for the landward migration of intertidal habitats such as saltmarsh under climate change scenarios.	Estuary Foreshores	All	GCC	CMA, DECCW	E8, P42, W60	P43	$ 60,000		0	2	3	3	0	0	-2	0	0	0	6	2		9
P32	Visual Amenity and Landscape Character	Planning	Develop a policy for the preservation of iconic views around the Estuary and its catchment.	Waterway-wide/Catchment-wide	All	GCC		C05	R30	$ 15,000		0	0	0	0	4	5	0	0	0	0	9	0		9
R30	Visual Amenity and Landscape Character	Research/Monitoring	Undertake a visual assessment of the Brisbane Water Estuary and identify important landscape types and iconic views.	Waterway-wide/Catchment-wide	All	GCC		P32		$ 80,000		0	0	0	0	4	5	0	0	0	0	9	0		9
R05	Water and Sediment Quality	Research/Monitoring	Keep a log of the volumes and types of material removed from GPTs during routine maintenance and incorporate this information into the water quality monitoring program.	Catchment-wide	All	GCC		R02, R06, R04		$ 63,564		3	0	3	0	0	0	0	0	0	0	6	2		9
P19	Habitat and Species Conservation	Planning	Develop a strategy for the conservation of areas (e.g. estuarine protected areas) important for the biodiversity of invertebrates. Particular attention should be paid to priority sites that represent the greatest proportion of species, including Ettalong, Narara Creek, Koolewong, and Woy Woy Bay-Pelican Island.	Ettalong, Narara Creek, Koolewong, and Woy Woy Bay-Pelican Island	All	GCC	DII - Fisheries, DECCW, University of Newcastle	P21, P22		$ 283,068		1	0	5	0	0	0	-2	0	0	3	7	1		8.5
P29	Habitat and Species Conservation	Planning	Develop a "Green Offsets" Policy aimed at: - Ensuring significant vegetation in the LGA is protected, - Facilitating some development that may have some negative environmental impacts, - Ameliorating the negative impacts of development at a local and regional scale, and - Providing for environmental enhancement and restoration.	LGA-wide	All	GCC		C05, C06		$ 150,000		1	1	2	0	0	1	0	2	0	0	7	1		8.5
R20	Habitat and Species Conservation	Research/Monitoring	Monitor indicator organisms within all ecosystems (saltmarsh, seagrass, mangroves, intertidal mud, subtidal mud, intertidal rock) through time to assess effectiveness of management measures to protect biodiversity and maintain the ecological health of the Estuary.	Waterway-wide/Catchment-wide	All	GCC	CMA, DECCW, DII - Fisheries	R36, R37		$ 920,491		0	0	4	0	0	0	0	0	0	3	7	1		8.5
W93	Recreational Usage	Works	Provide additional rubbish and recycling bins along the foreshore, focusing on access points and targeting heavily utilised foreshore reserves as a priority.	Estuary Foreshores	All	GCC			R31	$ 183,910		2	0	2	0	0	0	3	0	0	0	7	1		8.5

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E05	Information, Communications and Education	Education	Develop a public education and awareness program about the diversity of birds and the national significance of Brisbane Water Estuary for birds.	LGA-wide	All	GCC	CMA, DECCW, local bird watching clubs	C10, E03, E06, P23, P27, R26		N/A	Australian Bird Environment Foundation Grant	0	0	4	0	0	0	0	0	0	3	7	1		8.5
E10	Information, Communications and Education	Education	Provide information about environmentally friendly seawall options to both the community and those individuals assessing development applications for these structures. Reference should be made to DECCW's *Environmentally Friendly Seawalls. A Guide to Improving the Environmental Value of Seawalls and Seawall-lined Foreshores in Estuaries* .	LGA-wide	All	DECCW	GCC, LPMA	P43-P45, P48		$ 109,455		0	3	2	0	0	0	0	0	0	2	7	1		8.5
R29	Cultural Heritage	Research/Monitoring	Recognise the historic Aboriginal ownership and use of the area by undertaking research into local languages, customs and significant sites.	LGA-wide	All	GCC	DECCW	P31		$ 100,000	DEWHA Indigenous Heritage Program (up to $100,000)	0	0	0	0	5	0	0	0	0	0	5	2		8
P46	Foreshore Development	Planning	Review existing DCP 119 - Wharves and Jetties with a view to ensuring the policy is in accordance with the goals and objectives of the Estuary Management Study and Plan. In addition, sea level rise projections should also be considered where facilities are to be upgraded.	LGA-wide	All	GCC	LPMA	P45	P43	$ 12,500		0	2	2	0	0	1	0	0	0	0	5	2		8
P51	Foreshore Development	Planning	Implement development setbacks to provide for increased public access to the Estuary foreshores where new development occurs or existing sites are re-developed.	Estuary Foreshores	All	GCC		P50, P44, W82	P43	N/A		0	2	0	0	0	0	3	0	0	0	5	2		8
E01	Habitat and Species Conservation	Education	Distribute available NSW Maritime seagrass maps to boaters and anglers to reduce impacts on seagrass from dinghies, motors and anchors. These maps should enclose information about the community's obligations with respect to preservation of seagrasses, such as DPI's Recreational Fishing Handbooks, which contain information on marine conservation.	Registered Boat Owners	All	DII - Fisheries	CMA, Fishcare Volunteers	C08, E11, E13, P18, P21, P25, P34, R22, W658		$ 41,485		0	0	3	0	0	0	-1	0	0	3	5	2		8
W65	Habitat and Species Conservation	Works	Replace existing swing moorings within the Estuary with more appropriate, seagrass friendly moorings.	Waterway-wide	All	NSW Maritime		R31, R32	P36	$ 79,455		0	3	2	0	0	0	0	0	0	0	5	2		8
W73	Habitat and Species Conservation	Works	Conduct weed control activities in Council's foreshore reserves.	Estuary Foreshores	All	GCC	Bushcare Volunteers	W72		$ 79,455		0	0	5	0	0	0	0	0	0	0	5	2		8
W79	Habitat and Species Conservation	Works	Replace existing tide gates/flaps fixed to stormwater outlets with fish friendly tide gates/flaps.	Estuary Foreshores	All	GCC	DII - Fisheries	W66, W67		$ 309,850	Recreational Fishing Trust	0	1	4	0	0	0	0	0	0	0	5	2		8
P35	Recreational Usage	Planning	Develop a guideline for the installation of dinghy storage racks covering: - Suitable types of storage racks, and - Suitable locations for installation compatible with existing uses and ecological constraints.	Estuary Foreshores	All	GCC		C07, P36, W77	R31, W86	N/A		0	1	1	0	0	1	2	0	0	0	5	2		8
R32	Recreational Usage	Research/Monitoring	Undertake an audit of the number, configuration and demand for existing moorings in Brisbane Water Estuary. Assess the need to increase the number of moorings and identify suitable locations with due consideration of the carrying capacity of the Estuary. Moorings should be concentrated in close proximity to associated shore-based facilities (e.g. dinghy storage racks).	Waterway-wide	All	NSW Maritime		P36, W65	R31	$ 20,000		0	1	-2	0	0	3	3	3	0	0	8	0		8
W56	Foreshore Flooding/Inundation	Works	Seek to remediate scouring currently occurring behind the existing seawall in Illoura Reserve. This may necessitate replacement of the existing seawall with a new, environmentally friendly seawall structure.	Davistown	All	GCC	DII - Fisheries	W47, W48	W34	N/A		0	1	3	2	0	0	0	0	0	0	6	1		7.5
W68	Habitat and Species Conservation	Works	Investigate the issue of mangrove habitat expansion at the expense of other estuarine habitats (esp. saltmarsh). Key locations where this process is occurring should be identified and appropriate mangrove control management actions developed in conjunction with DII Fisheries.	Waterway-wide	All	GCC	DII - Fisheries, Volunteers	R20, W57, W58, W61, W76		$ 258,910		0	1	4	1	0	0	0	0	0	0	6	1		7.5
W72	Habitat and Species Conservation	Works	Conduct feral animal control in Council's foreshore reserves.	Estuary Foreshores	All	GCC		W73		$ 211,880		1	0	5	0	0	0	0	0	0	0	6	1		7.5
E12	Information, Communications and Education	Education	Distribute NSW Maritime's 'Don't Make Waves' brochure to the boating community.	LGA-wide	All	NSW Maritime		C8		$ 79,455		1	1	2	0	0	0	0	0	0	2	6	1		7.5
R25	Habitat and Species Conservation	Research/Monitoring	Monitor the status and extent of *Caulerpa taxifolia* in the Estuary and undertake a program of eradication.	Waterway-wide	All	DII - Fisheries	CMA	E13		$ 283,068	Recreational Fishing Trust	0	0	2	0	0	0	0	0	0	2	4	2		7
C10	Recreational Usage	Compliance	Enforce on-leash dog walking in restricted areas.	Catchment-wide	All	GCC				$ 317,820		-2	0	2	0	0	0	2	0	0	2	4	2		7
P33	Recreational Usage	Planning	Provide linkages between different portions of publicly accessible foreshores by linking with other foot or cycle paths and public transport linkages.	Catchment-wide	All	GCC		W41, W82, W84, W94, W104, W110		$ 20,000		0	0	0	0	0	0	4	0	0	0	4	2		7
P30	Habitat and Species Conservation	Planning	Develop a DCP for Wetlands aimed at maintaining and restoring natural biological and physical processes of wetland function by minimising changes to wetland hydrology from land uses in the catchment.	LGA-wide	All	GCC		C13, P04		$ 40,000		2	1	2	0	0	1	0	-1	0	0	5	1		6.5
P11	Sedimentary Processes	Planning	Develop standard designs or guidelines for retaining walls to ensure consistent character and appearance across all locations for which they are necessary.	LGA-wide	All	GCC				$ 12,000		0	2	2	0	0	1	0	0	0	0	5	1		6.5
W82	Recreational Usage	Works	Seek to provide a publicly accessible pathway along the entire Estuary foreshore. This should be approached in a strategic fashion incorporating: a) Linkages with existing cycleways, pathways and public transport in the wider catchment, b) Safety by Design (e.g. through the provision of lighting), and c) Consideration of environmental constraints (e.g. gridded/light permeable boardwalks may be more suitable in ecologically sensitive areas).	Estuary Foreshores	All	GCC	LPMA	P50-P52, W83, W84, W94		$ 1,324,252		-1	-1	0	0	1	2	5	0	0	0	6	0		6
W94	Recreational Usage	Works	Provide additional facilities for disabled and less mobile people, to include access ramps, seating, disabled parking etc.	Fagan's Bay, Woy Woy, Ettalong	All	GCC		W84, W85	R31	$ 1,235,641		0	0	0	0	0	0	3	0	0	0	3	2		6
W85	Recreational Usage	Works	Enforce the replacement of fixed public jetties with floating pontoons.	Waterway-wide	All	LPMA	GCC	P36, P46, W94		$ 2,330,683		0	2	0	0	-2	2	2	0	0	0	4	1		5.5
W60	Foreshore Flooding/Inundation	Works	Where possible, provide for managed retreat of infrastructure from foreshore areas likely to be affected by sea level rise.	Estuary Foreshores	All	GCC	DECCW		P43	$ 3,428,204		0	3	3	5	-3	0	-3	-3	0	0	2	2		5
P18	Habitat and Species Conservation	Planning	Develop a strategy to protect seagrass beds known to be important for syngnathid fishes (seahorses, pipefish).	Waterway-wide	All	GCC	DII - Fisheries	E01, P20-P22, P25, R20, W65		$ 140,940		1	0	4	0	0	0	0	0	0	0	5	0		5
C16	Information, Communications and Education	Compliance	Publish statistics on infringements of boating regulations.	LGA-wide	All	NSW Maritime		C09, C08	C08	$ 79,455	Recreational Fishing Trust - Aquatic Habitat	0	0	1	0	0	0	0	0	2	2	5	0		5
C09	Recreational Usage	Compliance	Install solar powered speed cameras in problematic areas for enforcement of speed restrictions for boats.	Waterway-wide	All	NSW Maritime		C16	C16	$ 60,000		0	1	0	0	0	0	1	0	0	1	3	1		4.5
W87	Recreational Usage	Works	Ensure that the navigation markers are moved in accordance with movement of the associated shoals.	Waterway-wide	All	NSW Maritime				$ 158,910		0	0	0	-1	0	0	4	0	0	0	3	1		4.5
W92	Recreational Usage	Works	Instead of collecting rubbish from the Estuary foreshores via beach raking, collect by hand (to avoid ecological impacts).	Estuary Foreshores	All	GCC	Volunteers, Work for the Dole Program			$ 476,731		0	1	2	0	0	0	0	0	0	0	3	1		4.5

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W95	Recreational Usage	Works	Provide special parking for people transferring small children to prams at key recreational areas.	Fagan's Bay, Ettalong	All	GCC		W96	R31	$ 25,000		0	0	0	0	0	0	3	0	0	0	3	1		4.5
W96	Recreational Usage	Works	Provide short-term 'loading zones' for recreational users (un)loading bikes or other equipment immediately adjacent to heavily utilised recreational sites.	Estuary Foreshores	All	GCC		W95	R31	$ 25,000		0	0	0	0	0	0	3	0	0	0	3	1		4.5
W66	Habitat and Species Conservation	Works	Provide fish friendly structures where new instream structures are being constructed.	Catchment Tributaries	All	GCC, RTA	DII - Fisheries	W67		$ 635,641	Recreational Fishing Trust	0	0	1	0	0	0	0	0	0	0	1	2		4
W67	Habitat and Species Conservation	Works	Identify existing instream infrastructure (e.g. weirs and culverts) for replacement or retrofitting to fish friendly status.	Catchment Tributaries	All	GCC, RTA	DII - Fisheries	W66		$ 645,641	Recreational Fishing Trust	0	0	1	0	0	0	0	0	0	0	1	2		4
W74	Habitat and Species Conservation	Works	Where feasible, clean up both active and inactive oyster leases to remove rubble, oyster shells and other rubbish.	Waterway-wide	All	DII - Fisheries	Volunteers	P17		$ 158,910		1	2	0	0	-1	1	1	0	0	0	4	0		4
P34	Recreational Usage	Planning	Investigate options for further zonation of the waterway for different water-based recreational activities, with due consideration of ecologically sensitive areas. This option would involve re-assessment of the existing boating map for Brisbane Water prepared by NSW Maritime.	Waterway-wide	All	NSW Maritime		P26 , P36, P37	P41	$ 55,000		3	0	1	0	0	0	-2	-1	0	0	1	2		4
P52	Foreshore Development	Planning	Assess the need to strengthen existing controls or develop new controls relating to foreshore development to provide for public right of way along the foreshore.	Estuary Foreshores	All	GCC		P44, P45, P52, W82	P43	$ 30,000		0	0	0	1	0	0	3	-2	0	0	2	1		3.5
C12	Recreational Usage	Compliance	Investigate options for either banning or further limiting the use of jet skis in Brisbane Water Estuary.	Waterway-wide	All	NSW Maritime	GCC	C08		$ 12,500		1	1	1	0	0	0	0	-1	0	0	2	1		3.5
P40	Recreational Usage	Planning	Identify 'green' alternatives for the disposal of seaweed removed from the Estuary foreshores (e.g. use in gardening activities).	Estuary Foreshores	All	GCC	Volunteers			$ 7,500		0	0	3	0	0	0	0	0	0	0	3	0		3
R08	Sedimentary Processes	Research/Monitoring	For each significant dredging option considered for implementation, establish dredging trials to determine the effectiveness of proposed dredging activities.	Waterway-wide	All	LPMA, GCC	NSW Maritime	P07, R09, W18-W25		$ 120,000		-1	3	-2	0	0	0	3	0	0	0	3	0		3
W58	Foreshore Flooding/Inundation	Works	Control mangrove growth where they are affecting key drainage channels.	Catchment Tributaries	All	GCC	Volunteers	W57, W61		$ 288,068	NSW Floodplain Management Program (pending outcome of Brisbane Water Floodplain Risk Management Study and Plan)	-1	1	-2	3	0	0	0	0	0	0	1	1		2.5
W09	Water and Sediment Quality	Works	Provide kerb and guttering for those roads that are currently unsealed/unfinished.	Woy Woy, Blackwall	All	GCC				$ 1,570,790		2	2	-4	-1	0	1	0	1	0	0	1	1		2.5
P55	Commercial Development	Planning	Investigate options for constructing new (and/or expanding existing) boating facilities.	Waterway-wide	All	LPMA, Private Developers	GCC	P54	R32	$ 100,000		-2	-2	-1	0	0	-1	4	4	0	0	2	0		2
R07	Sedimentary Processes	Research/Monitoring	Undertake analysis incorporating radiocarbon dating of sediments associated with the mouth of Mudflat, RSL and Woy Woy Creeks to identify the rate of sedimentation.	Hardy's Bay, Woy Woy	All	GCC		W06, W27		$ 32,000		0	2	0	0	0	0	0	0	0	0	2	0		2
C11	Recreational Usage	Compliance	Prohibit all vehicular traffic along the sand on beaches (excl. vehicles used by Surf Life Savers).	Estuary Foreshores	All	GCC, SLSA				$ 5,000		1	2	1	0	0	0	-1	0	0	0	3	-1		1.5
W89	Recreational Usage	Works	Provide additional off-leash dog walking areas.	Catchment-wide	All	GCC		C10, W91		$ 20,000		-2	0	-1	0	0	0	3	0	0	0	0	0		0
W81	Recreational Usage	Works	Seek to provide additional facilities for the boating community to include slipways, shipwright services, travel lifts, re-fuelling areas and hard stand areas. The form and location of these additional facilities should be such that they are accessible by a range of vessels over the full tidal cycle.	Estuary Foreshores/Waterway-wide	All	LPMA	GCC	P35, P36, R32, W02, W85	R31, P41	$ 2,330,683	NSW Maritime - Maritime Infrastructure Program	-3	-2	-2	0	0	-2	4	4	0	0	-1	0		-1
P03	Water and Sediment Quality	Planning	Investigate option of prohibiting 2-stroke outboard motors.	Waterway-wide	All	NSW Maritime	GCC			$ 10,000		2	0	2	0	0	0	-5	0	0	0	-1	0		-1
P21	Habitat and Species Conservation	Planning	Develop a conservation and education strategy for seagrass beds known to be important for sponges and ascidians: Point Clare, Saratoga, Kincumber, Yattalunga, Pretty Beach, Wagstaff Point.	Point Clare, Saratoga, Kincumber, Yattalunga, Pretty Beach, Wagstaff Point	All	GCC	DII - Fisheries, DECCW, University of Newcastle	E01, P18, P20, P22, P25, R20, W65		$ 140,940		1	0	5	0	0	0	0	0	0	3	9	1		10.5