



Final Report

**Curl Curl Lagoon Estuary Management
Plan**



For

Warringah Council

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Summary

In accordance with the New South Wales Government's Estuary Management Policy (and the guidelines established to help local government implement this policy – New South Wales (NSW) Government 1992), Warringah Council has embarked on the process required to sustainably manage the Curl Curl Lagoon estuarine environment. With respect to the eight-step process outlined in the manual, finalisation of this Estuary Management Plan represents completion of Step 6. The comments received as a result of the public review phase of the draft plan (Step 6) have been duly considered in this final Estuary Management Plan.

Recognition of the lagoon's highly modified state in the early stages of the management process led to the development of a rehabilitation plan for Curl Curl Lagoon and Greendale Creek (Patterson Britton & Partners 1992). The underlying aim of the rehabilitation plan has formed the basis of the Estuary Management Plan, which is to improve the aesthetic value and ecological health of the lagoon system. Considering the degraded nature of the ecosystem, objectives that have been developed are more related to rehabilitation of the lagoon so that it resembles, and functions like, a more 'natural' system. It should be recognised that objectives to maintain the natural integrity of the Curl Curl Lagoon system are inherently long term. As the positive environmental effects from the completion of lagoon rehabilitation manifest themselves, these objectives will become more achievable.

This Estuary Management Plan provides a tabulated presentation of integrated actions required to return the lagoon to a more 'natural' operating system and clearly identifies the processes that need to be understood before any respective measurable goals can be set. While objectives for the management of these processes are not quantified, strategies to achieve the required more comprehensive knowledge are proposed. Initiatives are associated with the relevant ecosystem or social component being managed. Management objectives, strategies and actions are divided into geographical units to aid in practical implementation of the plan, and are associated with priorities, the term (from short to long term) and responsible agents for implementation.

The environmental outcomes of the actions associated with the lagoon's and creek's rehabilitation will be able to be assessed through the adoption of the relevant monitoring program modules (as detailed in the draft *Curl Curl Ecological Monitoring Report* – Australian Water Technologies 2000). Along with the assessment of outcomes, there will be an amplified need for dynamic review of the plan and modification and/or formulation of new management objectives. This will ensure its consistency and appropriateness relative to the changing environment as it is rehabilitated.

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1 Introduction

1.1 The Status of Curl Curl Lagoon

The Curl Curl Lagoon Ecosystem

Curl Curl Lagoon is the smallest of four coastal lagoons (also including Dee Why, Narrabeen and Manly Lagoons) located within Warringah Council. The total surface area of the lagoon is approximately 5.7 hectares (ha). The Curl Curl Lagoon catchment, an area of approximately 440 ha, supports predominantly residential and industrial development and land uses. The study area for the Curl Curl Lagoon ecosystem (see Figure 1) extends from the ocean (at North Curl Curl Beach) to the Harbord Road limit of Greendale Creek. Greendale Creek constitutes the primary tributary of the lagoon. Downstream of Harbord Road, where the creek exits the Brookvale industrial estate, the waterway is an open system with extensive foreshores, which are used predominantly for recreation.

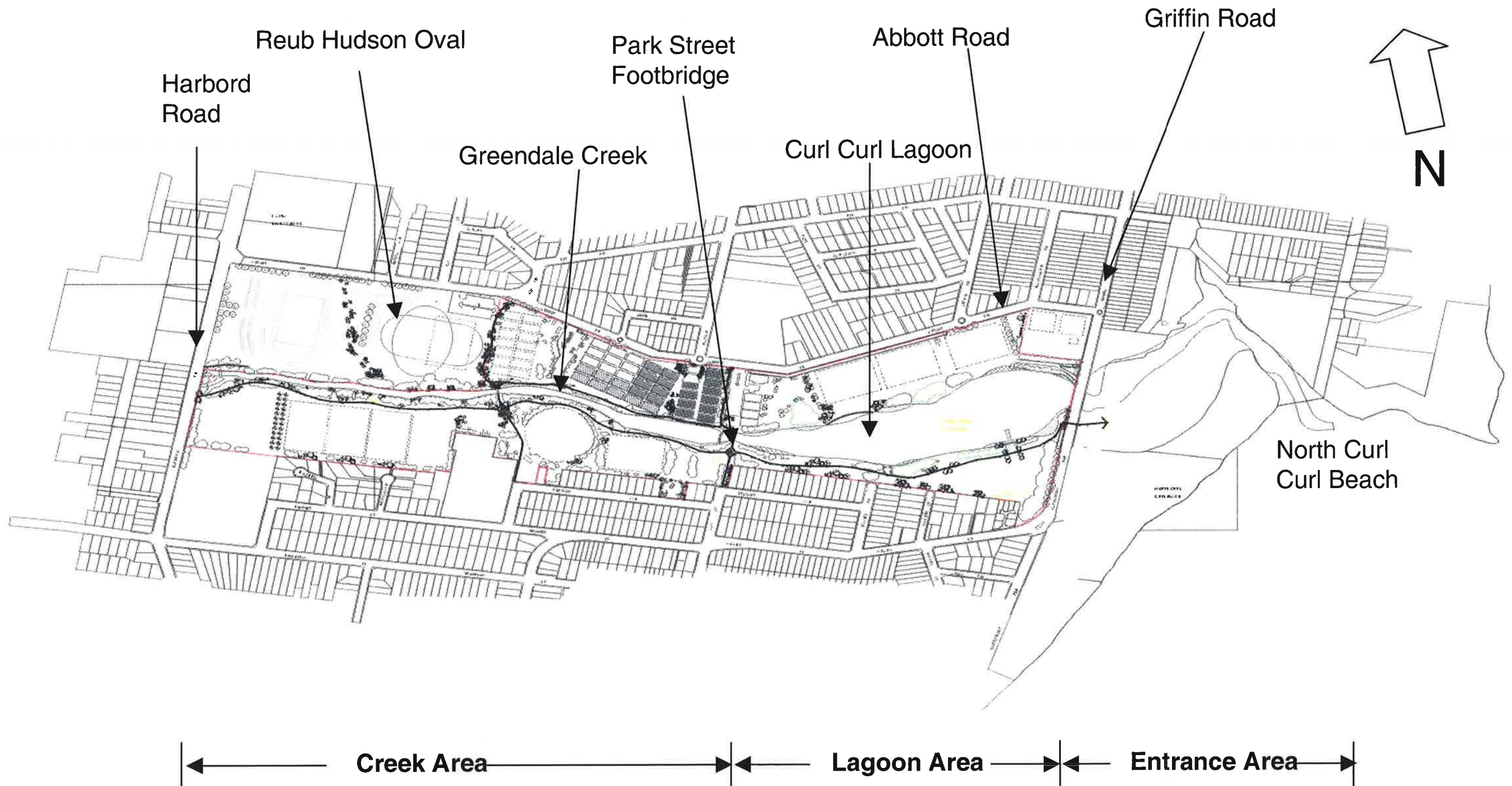
In accordance with the New South Wales Government's Estuary Management Policy (and the guidelines established to help local government implement this policy – New South Wales (NSW) Government 1992), Warringah Council has embarked on the process required to sustainably manage the Curl Curl Lagoon estuarine environment.

Recognition of the lagoon's highly degraded state in the early stages of the management process (especially in terms of water quality and habitat) led to the development of a rehabilitation plan for Curl Curl Lagoon and Greendale Creek (Patterson Britton & Partners 1992). Activities proposed in the plan are designed to develop these areas as a favourable environment for flora and fauna and an attractive recreational area for the public. More broadly, the underlying aim of the rehabilitation plan is to improve the aesthetic value and ecological health of the lagoon system. The justification and expected outcomes of the rehabilitation activities for this system are detailed in *Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects* (PB&P - 1994a) and *Greendale Creek Rehabilitation Project Statement of Environmental Effects* (PB&P 1994b).

The Stages of Rehabilitation

The works considered necessary to achieve the rehabilitation aims have been divided into four stages, all of which will be completed over several years (PB&P 1992). In practice, each of the planned rehabilitation stages (stages 1 through 4) focuses on adjacent sections of the lagoon ecosystem, extending from the lagoon's entrance at the ocean (North Curl Curl Beach) to Greendale Creek at Harbord Road. These stages are being undertaken progressively in a downstream (eastward) direction (see Figure 1).

Figure 1. Study Area for the Curl Curl Lagoon Estuary Management Plan



Stages 1 and 2 have been completed and Stage 3 works will commence in March/April 2000. So far, the rehabilitation works have been undertaken only in Greendale Creek (and associated foreshores), upstream (west) of the Park Street Bridge. The rehabilitation works planned for the lagoon body proper, constitute the final major stage (Stage 4) of the rehabilitation plan. Details of each stage of the rehabilitation works are included in the Management Schedule (Section 3.3).

Given the advanced stage of management for Curl Curl Lagoon, Warringah Council now requires a review of the completed and proposed actions in the form of a Estuary Management Plan.

1.2 Estuary Management Process

The Estuary Management Manual (NSW Government 1992) describes estuary management as an eight-step process, which is summarised in Figure 2.

Step 1, the formation of an Estuary Management Committee, was completed in 1991. This committee oversees the estuary management process for Curl Curl Lagoon and its neighbour, Dee Why Lagoon.

The collation of available data and the conduct of estuary management processes and management studies (Step 2 through to Step 4 – Figure 2) were essentially completed through the development of the Curl Curl Lagoon and Greendale Creek rehabilitation programs. The objectives for rehabilitation were developed with issues such as nature conservation, land use and the community in mind. A range of ecological, developmental and education objectives were also determined in conjunction with the rehabilitation plan objectives. Due to the degraded nature of the ecosystem, rehabilitation issues are a dominant component of the management process at this stage. In future, as the progressive rehabilitation stages are completed, other issues such as monitoring and maintenance of the rehabilitation works are likely to take precedence.

Step 4 of the estuary management process, ‘conduct of the management study’, usually involves the development of appropriate management objectives for the particular system being examined. Considering the highly modified state of the lagoon and creek, objectives that have been developed in relation to the system are more related to rehabilitation of the lagoon so that it resembles, and functions like, a more ‘natural’ system.

It is recognised that objectives designed to maintain the natural integrity of the Curl Curl Lagoon system are highly dependant on the adoption and completion of the rehabilitation measures planned for the lagoon (as detailed in PB&P 1994a and 1994b). Because of the multiple-stage nature of the rehabilitation works, the manifestation of positive environmental effects in the Curl Curl Lagoon system will be gradual. The environmental outcomes of the actions associated with the lagoon’s and creek’s rehabilitation will be able to be assessed through the adoption of the relevant monitoring program modules (as detailed in the draft *Curl Curl Ecological Monitoring Report* – Australian Water Technologies (AWT) 2000 – and discussed in Section 2.2).

Along with the assessment of outcomes, there will be an amplified need for dynamic review of the plan and modification and/or formulation of new management objectives.

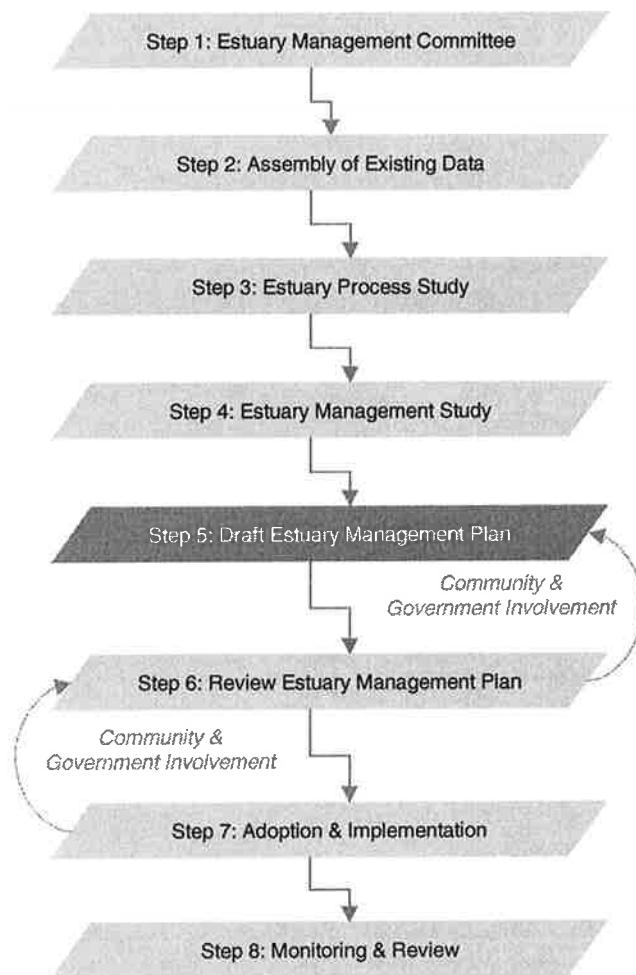


Figure 2 Summary of the Eight-Step Estuary Management Process.

For Curl Curl Lagoon, this management plan integrates the actions required to return the lagoon to a more 'natural' operating system and clearly identifies the processes that need to be understood before any respective measurable goals can be set. While objectives for the management of these processes are not quantified, strategies to achieve the required more comprehensive knowledge are proposed.

Steps 6 and 7 of the estuary management process involve review of the Estuary Management Plan and implementation of the final plan, respectively. The aim of Step 8 is to ensure that management and related activities are monitored and subjected to ongoing review, assessment and refinement to ensure that the plan remains flexible. This will ensure its consistency and appropriateness relative to the changing environment as it is rehabilitated.

1.3 Objectives of the Plan

The specific objectives for the development of the draft *Curl Curl Estuary Management Plan* are:

- To assess and integrate the management objectives identified in PB&P (1992) with the outcomes and recommendations of other relevant documents on Curl Curl Lagoon and its environs;
- To relate management actions, wherever possible, to specific estuarine processes, thus enabling their effects and outcomes to be determined;
- To provide Warringah Council with a workable document with the management schedule detailed in table format, with the format including a map of the lagoon and catchment, with strategic actions grouped by location; and
- To provide a document suitable for display to the community, with a graphical and pictorial representation of ideas where appropriate.

1.4 Scope of the Plan

Curl Curl Lagoon's major tributary, Greendale Creek, has a major impact on the lagoon ecosystem. Additionally, the state and uses of the lagoon and creek foreshores, which extend westward to Harbord Road, determine to a large degree the integrity of the estuarine ecosystem. The Estuary Management Plan, encompasses management objectives relevant to the larger catchment area, and, in effect, includes strategies relevant to freshwater, estuarine and marine habitats.

In line with the recognition that a desirable outcome includes integrated coastal management, relevant issues and objectives highlighted in management plans for areas within the larger Northern Beaches catchment are also addressed.

The Estuary Management Plan comprises a working document that integrates and tabulates the various proposed and completed management objectives, strategies and actions planned for the lagoon ecosystem. The strategies designed to help meet the objectives are firstly categorised as short, medium and long term and then prioritised in relation to their proposed implementation time frame. Responsible and secondary parties for each strategy are also proposed and documented in the estuary management schedule.

In relation to the funding that will be required for undertaking particular strategies, the Estuary Management Plan outlines potential sources for Warringah Council's consideration. Overall, the plan is integral to the effective long-term management of the lagoon, and provides a means of assessing whether the broad aim of improving the ecological and aesthetic lagoon components is being achieved.

The Estuary Management Plan is subject to a review process (Step 7) that will allow all interested or affected parties the opportunity to assess the proposed measures, to register any further ideas and/or to suggest modifications. Necessary amendments are then incorporated into the final Plan. Section 4.1 details this process as well as the community consultation that took place during the draft plan's development.

2 Existing Management of the Lagoon Environment

2.1 Management framework of Curl Curl Lagoon

This document specifically applies to the management of Curl Curl Lagoon. However, there are a number of other management plans that apply to the lagoon and surrounding areas that have been considered during the preparation of the Estuary Management Plan. The Estuary Management Plan for Curl Curl Lagoon fits into Warringah Council's overall management structure for the community land that forms part of the "greater lagoon area". The management plans for the immediate surrounds of the lagoon and creek include:

- *John Fisher Park and Environs Plan of Management* (Warringah Council, 1998a); and
- *Geographic Plan of Management for Coastal Community Lands* (Warringah Council, 1998b).

The former document covers the area from Harbord Road extending east to Griffin Road. The latter plan of management covers the community lands from the eastern side of Griffin Road to the coastal waters. These management plans dictate which activities are permissible within the boundaries of the respective areas they define. They are intended more as a "framework" for management of the respective study areas rather than as all encompassing documents.

Other planning documents for nearby geographical areas and/or components of these areas include:

- *Abbott Road Land Plan of Management* (Warringah Council 1996) - covering the area adjacent to the John Fisher Park and environs;
- *Recreation Strategy for Warringah's Beaches and Coastal Open Space* (Warringah Council 1998c); and
- *Northern Beaches Stormwater Management Plan* (Patterson Britton and Partners – PB&P 1999).

This estuary management plan has been prepared in consideration of these plans and is intended to compliment the strategies and objectives proposed for the areas surrounding the lagoon and creek.

Planning documents specific to the study area covered by this estuary management plan include:

- *Greendale Creek and Curl Curl Lagoon Stormwater Treatment and Management Plan* (PB&P 1997);
- *Curl Curl Lagoon Rehabilitation Study* (PB&P 1992);

- *Curl Curl Lagoon Rehabilitation Project – Statement of Environmental Effects* (PB&P 1994a); and
- *Greendale Creek Rehabilitation Project – Statement of Environmental Effects* (PB&P 1994b).

The appropriate management objectives and associated actions detailed in these documents have been incorporated into this plan.

2.2 Completed Actions

Since the completion of the Curl Curl Lagoon Rehabilitation Study in 1992 (PB&P 1992), stages 1 and 2 of the rehabilitation works have largely been completed and Stage 3 works, which involve the Greendale Creek inflow to the lagoon, are planned to commence in March or April 2000.

In summary, the major structural and mechanical works in the upstream reaches of the creek have been completed. Habitat management, mainly through landscaping initiatives (including earthworks and revegetation), has also commenced in sections of the creek and along its foreshores. Completed actions, forming part of the various stages of the rehabilitation plan for the study area are detailed in the Management Schedule (Tables 1-5, Section 3.3).

In conjunction with the rehabilitation plan, the *Greendale Creek and Curl Curl Lagoon Stormwater Treatment and Management Plan* (PB&P 1997) proposes an implementation schedule for structural improvements to stormwater outlets. This schedule considers stages of major public works planned for the creek and lagoon and integrates rehabilitation and stormwater improvements where appropriate, necessary and/or practical.

A large proportion of the various management plans' actions (such as revegetation and planned improvements to stormwater outlets) will be ongoing. Following the completion of specific measures, the process of performance monitoring and review will become important. This process will allow the success and efficiency of the improvement measures at meeting the set objectives of this plan to be assessed. A list of actions completed (and planned) which relate to the stormwater treatment and management schedule (outlined in PB&P (1997)) are incorporated into the management schedule of this Estuary Management Plan (Tables 1-5, Section 3.3).

2.3 Related Management Activities

Industrial Audits

Brookvale Industrial Estate

Warringah Council initiated and completed an environmental audit of industrial premises in the Brookvale Industrial Estate in 1995. Brookvale Industrial Estate is bound by Harbord Road in the west, and by Pittwater Road in the north and east. The aim of the audit was to determine the potential pollution sources that could affect the water quality of Greendale Creek and Curl Curl Lagoon.

About 20 percent of all businesses audited were identified as having the potential to contribute to stormwater pollution. The “Auto Services” category of businesses accounted for the largest portion of business types of all those categories inspected. About 42 percent of the “Auto Services” businesses were identified as potential pollution sources.

The study proved to have been a valuable activity in the exchange of information between Warringah Council and the local business community stakeholders. Warringah Council was able to learn of on-site industrial management practices. In turn, industrial representatives learned of pollution problems and were advised on possible modifications that would reduce the potential to impact upon water quality in the catchment. Hence, aside from identifying areas that require better management, an additional positive outcome of the study was increased environmental awareness and communication in relation to industrial activities.

Continuous Industrial Auditing Program

Council operates a continuous audit program, coordinated by the Catchment Liaison Officer, with the objective of reducing inputs of pollutants to Warringah’s creeks, lagoons and beaches via the stormwater system.

The two major aspects of the auditing program are education and compliance. Audits are carried out in premises from a variety of industries including construction, auto-repair and horticulture.

Silt and Sedimentation Control

The Silt and Sediment Control Program aims to reduce the impact that the building and construction industry has on stormwater and receiving waters in Warringah. This program is coordinated by the Council’s Silt and Sedimentation Control Officer who conducts regular field inspections in order to ensure that compliance with relevant legislation and building practices is achieved.

Ecological Monitoring Program

In conjunction with initiating the preparation of this plan, Warringah Council instigated a study to investigate the existing water quality of Curl Curl Lagoon and its catchment waters and to develop an ecological monitoring program for the future management of the lagoon system. Development of the monitoring program draws closely on the existing program, especially in light of extending the historical database, and its effectiveness in achieving the objectives adopted for the catchment. Details of the proposed ecological monitoring program can be found in the draft *Curl Curl Lagoon Ecological Monitoring Program* (AWT 2000).

The adoption of an effective and scientifically meaningful ecological monitoring program forms an essential component of this Estuary Management Plan. By undertaking specific modules of the monitoring program, and reviewing the results obtained, the success (or otherwise) of the various actions proposed in the Management Schedule, in terms of meeting the relevant objective, can be measured. Therefore, the monitoring program and its proper application will be fundamental to the review of the plan, its strategies and objectives. The three monitoring program modules are detailed in the Management Schedule (Tables 1-5, Section 3.3.) and detailed in AWT (2000).

3 Estuary Management Plan

3.1 Refinement of Objectives, Strategies and Actions

Review and Definition of Objectives, Strategies and Actions

Available documentation relating to studies conducted in the Curl Curl Lagoon and adjacent catchments were reviewed. The review provided details of any objectives and strategies adopted for the lagoon system and recommendations proposed for the area's rehabilitation. The types of documents that were scrutinised¹ include those relating to:

- Stormwater management plans;
- Sewerage system proposals;
- Environmental studies conducted in or around the lagoon;
- Plans for rehabilitation and/or management of various components of the catchment; and
- Statements on the health of the environment in and around the lagoon.

In addition to the document review, Warringah Council and the Dee Why Lagoon and Curl Curl Lagoon Estuary Management Committee were consulted for their local knowledge of any further objectives that would generally be accepted by the broader community.

In order to integrate the range of statements relating to the lagoon's future management, it was necessary to define the way these would be explained and related to other statements within this plan. Whether the statements were written as objectives, strategies or actions was usually dependent on the scope and context of the document within which they appeared.

Hence, for ease of users of this plan, the statements were categorised as "objectives", "strategies" or "actions", based on the definitions described below. These definitions were based on the premise that the underlying aim (adopted from the rehabilitation plan – PB&P, 1992), is to improve the ecological health and aesthetic value of the lagoon system, thus facilitating public recreation and enjoyment.

¹ A full list of the documents reviewed for the Curl Curl Estuary Management Plan is included in the Consultant's Brief for the Project.

Definitions adopted for the plan, are:

- Objective - a broad aim to improve public amenity, ecological integrity and/or public health and safety or a component of these issues;
- Strategy – a means of approaching the objective, often defining specific area(s) within the catchment or specific issues that need attention (given that several strategies might be required to achieve the overall objective); and
- Action – components of a strategy that specify achievable and often measurable tasks. These can be undertaken over the short, medium or long term in the management of the lagoon.

Objectives, strategies and actions are outlined in the Management Schedule (Section 3.3).

What environmental and social aspects does the plan aim to manage?

During integration and development of existing and new objectives (and associated strategies and actions), it became clear that each statement relates to a particular important issue in relation to the lagoon's management. Management objectives in the plan have therefore been assigned as addressing the following broad issues:

- Ecosystem Integrity, including:
 - water quality;
 - air quality;
 - landscape;
 - habitat value and biodiversity;
 - lagoon sediment quality;
 - lagoon breakouts; and
- Public Amenity, including:
 - site planning and design;
 - land use;
 - aesthetic quality; and
- Public Health and Safety.

Associated Stakeholder Issues

As detailed in Section 4.1, particular issues raised by Curl Curl Lagoon Friends were considered in the formulation of management objectives, strategies and actions for the Curl Curl Lagoon system. These issues, and the manner in which they are incorporated into the Estuary Management Plan, are discussed in the following sections.

Creation of a permanent water body and dredging

In view of the history and the surroundings of Curl Curl Lagoon, it was widely agreed that rehabilitation measures should work towards improving the general integrity of the system. In line with this, the creation and maintenance of a permanent water body was suggested, primarily to improve the aesthetic quality and amenity of the lagoon but also to provide a consistent ecological niche around which typical estuarine organisms can be sustained.

The Estuary Management Plan recognises this goal in that it encompasses a method whereby necessary components are managed in order to achieve this goal.

The dredging involved in the creation of the permanent water body raises several issues (which were assessed during the course of the rehabilitation study - PB&P 1992 and statement of environmental effects - PB&P 1994a, 1994b), which include:

- firstly, dredging has the potential to trigger the release of otherwise sediment-trapped contaminants into the water column;
- secondly, a deeper body of water may be harder to manage.

It is important that management ensures that input of sediments and contaminants into the lagoon are minimised. Additionally, management must ensure that the water body is constructed in such a way that it does not dramatically alter the pathways of substances through the system, resulting in negative impacts on ecosystem integrity (for example, changed transfer of materials and accumulation spots for pollutants).

Council will need to monitor the permanent water body to assess its relative impact on factors such as nutrient remineralisation and transport, the integrity of benthic populations and the ensuing impact on water quality.

Dredging should only be undertaken after the effective assessment of potential risks and environmental impacts on the lagoon associated with issues such as sediment contaminants, destabilisation of the lagoon floor, and impacts on the benthic flora and fauna. The depth and the extent of the dredging should be considered in terms of potential impacts on the hydrodynamics of the lagoon in its various states (ranging between open and drained, closed and full). Potential impacts on other important aspects of the lagoon ecology (for example, flora and fauna) which are linked with lagoon hydrodynamics should also be assessed.

Acid sulphate soils, land filled areas and leachate

Acid sulfate soils have the potential to negatively impact on the lagoon where they oxidise and release acids and associated nutrients. In view of this, accurate mapping of such soils (impinging either directly on the lagoon or on its catchment) is required, with the specific aim of identifying the following:

- current sources of leachate and contaminants;
- areas of high risk for leachate and contaminants based on their current status; and
- areas of risk (in terms of acid sulfate and contaminated soils) associated with long term developments (for example, construction and alterations of catchment flows).

This information should be obtained prior to the conduct of construction-related activities and considered in the development of Acid Sulfate Soil Management Plans and Contaminated Soil Management Plans.

Stormwater and sewer overflow management

The Estuary Management Plan incorporates the aim of minimising stormwater and sewage inputs into the lagoon. Until this can be achieved, it is necessary to monitor inputs from these sources as well as the quality of the receiving water.

Another of Council's aims should be to assess the relative significance and relative risks to public health and hazards impacting on the lagoon's ecological integrity. In order to achieve this, relevant studies previously conducted by Sydney Water should be followed up or updated. Furthermore, Council's management strategy should aim to develop a strong dialogue with Sydney Water with respect to monitoring and management of Sydney Water's sewerage system impacts on the relevant receiving environments.

Silt impact and management

Warringah Council should ensure that responsible bodies are aware of the need to minimise the input of silt and sedimentary material into the Curl Curl Lagoon catchment from various sources (including stormwater, sewerage overflows and urban runoff). Furthermore, council should also consider the development, where appropriate, of wetland areas and other options that entrap and stabilise silt and sedimentary particles (see following section).

Wetland restoration

Warringah Council should aim to design and develop wetlands at strategic locations on the fringes of the lagoon and along its primary tributary, Greendale Creek. Wetlands should be designed to maximise the diversity of native flora and to maximise the mitigation of sediment and pollutant transport into the lagoon.

Council should also ensure that the effectiveness of any constructed wetlands is assessed over time (for example, the proposed wetland associated with Stage 3 of the lagoon and creek rehabilitation works).

Given the nature of the Greendale Creek channel at present, and its proximity to well-established recreational areas, an emphasis should be placed on designing wetlands that do not require extensive maintenance, to minimise their encroachment on these recreational sites.

Biodiversity and habitats

Considering its history of significant anthropogenic impacts and modification - in particular, its use as a refuse tip - the low diversity of species associated with Curl Curl Lagoon is not surprising.

In view of this, it is necessary that habitat-improvement programs (including planting of native species, building riffles in streams) be encouraged. This, in turn, will encourage the return of fauna species, thus increasing the local biodiversity. Such improvements can be assessed by yearly biodiversity studies.

It should be noted however that, to date, an emphasis has been placed on assessing vertebrate diversity. Determining the true biodiversity of the system is limited by the lack of knowledge about the system's associated invertebrate and microbial species.

Benthic communities: invertebrates and seagrass

The currently available information indicates that Curl Curl Lagoon contains a benthic community typical of a heavily impacted ecosystem (PB&P 1992).

Warringah Council's primary target should be to improve the water quality and the integrity of the lagoon system (through rehabilitation measures detailed in Tables 1-5, Section 3.3). It is beyond Council's capacity to more directly manipulate benthic populations. As a consequence, an appropriate aim is to improve conditions in the system necessary for the maintenance of a healthy community of flora and fauna. To this end, activities such as wetland development and the minimisation of sewerage overflows and stormwater inputs (containing pollutants and contaminants) will all contribute towards reducing anthropogenic impacts establishing a more diverse community in the lagoon system.

Fish

Biodiversity of fish species is expected to be low due to the history of Curl Curl Lagoon. The abundance and distribution of fish species should be assessed in conjunction with rehabilitation works, especially as Stage 3 rehabilitation measures will significantly alter the continuity of the lagoon and creek systems.

Options available to Council are the same as those detailed for benthic organisms (see previous section) with the added necessity to comply with specific fisheries legislation and management plans.

Dunes

Dunes are an important feature of the coastal environment, playing a critical role in the maintenance of habitat and ecosystem integrity. With respect to Curl Curl Lagoon, Council must ensure that the dunes are not destabilised or contaminated in any way by the rehabilitation measures (for example, dredging and deposition of dredge material). Furthermore the Curl Curl lagoon foreshore dunes, used for earlier landfill operations, contain waste material, some of which is exposed and even finding its way into the entrance channel on the southern side of the lagoon. If managed properly, the dunes will not represent a source of silt and pollution for the lagoon and catchment components. Should it be necessary for such material to be placed in the dune area, strong safeguards need to be put in place to prevent lagoon contamination (including, but not limited to, physical barriers and planting of natural vegetation to stabilise and minimise loss of material).

Maintenance and review of management initiatives

In view of the significant rehabilitation program undertaken in the lagoon system, it is vital that Warringah Council put in place a system of maintenance and monitoring. This system will ensure that the various initiatives are maintained in accordance with their designed role, and that monitoring is undertaken to assess performance over time. This concept is highlighted in AWT (2000) and reflected in the Estuary Management Guidelines (NSW Government 1992). The results of this monitoring program need to be actively reviewed and initiatives reassessed on a yearly basis (refer to Section 3.4). This time frame could be expanded upon evidence that the system has established some form of stability.

Catchment

This Estuary Management Plan acknowledges that Curl Curl Lagoon sits within its surrounding catchment and is dependent on the same for its function. Relevant catchment-related management reports and plans are considered in the Estuary Management Plan and Schedule.

Education

It is recommended that Warringah Council continue with the various education-related initiatives, incorporating the specific actions detailed in the Management Schedule. Ongoing review and feedback from the community of such programs to ensure the relevance of information is essential.

Stage 4 rehabilitation works

With respect to dredging of the lagoon, Council must ensure that dredging controls are in place for the duration of the associated activities. In addition,

activities must be conducted in a manner that minimises the potential for negative impacts on the hydrology of the system (in terms of mixing processes and stratification). As Stage 4 rehabilitation works proceed, it is imperative that any actions undertaken do not negatively impact on the existing natural functions that are critical to ecosystem integrity (or curtail efforts to reinstate such processes).

3.2 Structure of the Management Plan

Physical Division of the Curl Curl Lagoon System

Again, for ease of reference for the user, and to ensure consistency with the structure of the rehabilitation plans proposed for Curl Curl Lagoon (PB&P 1992), the system is divided into clear geographical units, each of which need to be managed (refer to Figure 1). The geographical units adopted for the plan include:

Entrance	from North Curl Curl Beach waters (into which the lagoon discharges during breaching) to Griffin Road Bridge;
Lagoon	or the “lagoon proper” that extends from Griffin Road Bridge to the confluence of Greendale Creek and the lagoon waters (immediately downstream of Park Street footbridge); and
Creek	includes Greendale Creek from the eastern side of Harbord Road to the creek’s confluence with the lagoon.

It should be noted that division of the system into these components does not negate the need to consider the range of objectives, strategies and actions on a wider catchment basis. The repetition of some issues, actions and strategies relevant to one or more geographic areas (see Tables 1-5, Section 3.3) reflects this idea. Where objectives and the associated actions relate to all areas (and, often, to the wider catchment beyond the western boundary of Harbord Road), the geographic area is termed “All” in the Management Schedule. The use of such geographical division merely aids in the practical presentation and on-site implementation of the plan.

Assignment of Responsibility

The organisations and/or parties responsible for overseeing and/or undertaking the management actions proposed for Curl Curl Lagoon system are detailed in the Management Schedule.

Implementation Schedule Rationale

The management actions for the Curl Curl Lagoon system are assigned a time frame over which they are to be completed. These are expressed in terms of “short term”, “medium term” and “long term” (or “ongoing”), which are defined as follows:

- Short term – within two (2) years;
- Medium term – greater than two (2) years and within five (5) years; and
- Long term – Five years or longer.

In addition, “high”, “medium” and “low” priority is assigned to each of the actions. Determination of priorities was based on:

- The advanced stage of the implementation of the Curl Curl Lagoon and Greendale Creek Rehabilitation Plan (PB&P 1994a, 1994b) and the general acceptance of this plan by Warringah Council, stakeholder groups and the community;
- The prioritisation of actions in other relevant management plans adopted by Warringah Council. This includes the implementation schedule and priorities assigned to stormwater improvements in the catchment and the integration of these measures with the various stages of the rehabilitation plan;
- The paucity of data available on the estuarine processes acting within the system and the need to obtain baseline information. Such data will confirm (or otherwise) the appropriateness of management actions;
- The relative cost (implementation and maintenance) of actions and the availability of associated funding; and
- The short versus longer-term effects of the action as perceived by the community and stakeholders.

Following discussions with Warringah Council and Curl Curl Lagoon Friends, it was decided that a high priority management schedule would be useful for practical implementation and organisation of actions in the short term. This high priority schedule is provided in Table 6. The actions contained in this table relate mainly to the lagoon area.

3.3 Management Schedule

The management schedule is presented in tabular form (Tables 1-6) and structured in the manner described in Section 3.1 and Section 3.2. A comprehensive pictorial representation of the plan, in terms of the strategic actions and their physical location within the lagoon system, is provided in Figures 3a & 3b.

KEY (Tables 1-6):

Short term – Within two (2) years

Medium term – Greater than two (2) years and within five (5) years

Long term – Five years or longer

WC – Warringah Council

CCL – Curl Curl and Dee Why Lagoons Estuary Management Committee

SWC – Sydney Water Corporation

NA – Not available (at this stage)

Table 1. Management Schedule of Creek Area								
Objective	Strategy	Action	Detail	Status/ Implementation Schedule	Priority	Cost	Responsibility	Code
Ecosystem Integrity - water quality								
To improve the water quality in terms of managing inputs of contaminants, nutrients and sediments.	Manage land filled areas adjacent to the creek in order to minimise detrimental effects on lagoon ecosystem.	Monitor performance of rehabilitation measures in terms of mitigating leachate inputs into lagoon.	Adopt relevant modules of monitoring program to assess performance of rehabilitation measures.	Long term. (Ongoing.)	High	Staff costs	WC	C2011
		Assess wetland types and their potential use within the Curl Curl catchment to minimise solid and dissolved contaminant inputs into the lagoon.	Initiate study to assess potential use of wetland near the Park Street weir.	Short term. (In conjunction with Stage 3.)	Medium	Staff costs	WC	C2012
	Manage sewerage overflows into the creek.	Continue close liaison with Sydney Water representatives regarding the improvements to the sewerage system in the Curl Curl Lagoon Catchment.		Long term. (Ongoing.)	Medium	Staff costs	WC, SWC	C2021
To provide strategies for mitigation, control and/or treatment of pollutant sources into Greendale Creek.	Development of Greendale Creek and Curl Curl Lagoon Stormwater Treatment and Management Plan.	Inventory of stormwater outlets into waterways and development of management strategy.		Complete.	NA	NA	WC	C2111
		Priority schedule of stormwater outlets requiring treatment in line with planned rehabilitation measures.		Complete.	NA	NA	WC	C2112
		Undertake high priority treatment and upgrade measures as detailed in PB&P (1997).		Completed in conjunction with Stage 2 rehabilitation works.	High	NA	WC, SWC	C2113
		Completion of remaining treatment measures as detailed in PB&P (1997).		Long term and in conjunction with Stage 3 rehabilitation work as required. (Ongoing.)	High	NA	WC	C2114
	Proceed with preferred water quality improvement measures as detailed in the Greendale Creek rehabilitation Project Statement of Environmental Effects (PB&P 1994b).	Install gross pollutant trap in Greendale Creek immediately downstream of Brookvale Industrial Estate.	Construction of Harbord Road gross pollutant trap.	Complete.	NA	NA	WC	C2121
To enhance the existing natural self-purification processes in Greendale Creek.	Proceed with preferred water quality improvement measures as detailed in the Greendale Creek Rehabilitation Project Statement of Environmental Effects (PB&P 1994b).	Increase hydraulic residence time to favour nutrient removal.	Conduct selective minor widening and deepening of creek (Stage 2).	Complete.	NA	NA	WC	C2211
			Conduct selective minor widening and deepening of creek (Stage 3).	Short term. (Fully completed in conjunction with Stage 3.)	High	To be determined from total Stage 3 budget (\$770,000)	WC	C2212
			Construct weir at Park Street footbridge (Stage 3).	Short term. (Fully completed in conjunction with Stage 3.)	High		WC	C2213
		Provide plants for nutrient-uptake related benefits.	Revegetate riparian and aquatic habitats (Stage 2).	Complete.	NA	NA	WC	C2214
			Revegetate riparian and aquatic habitats (Stage 3).	Short term. (Fully completed in conjunction with Stage 3.)	High	To be determined from total Stage 3 budget (\$770,000)	WC	C2215
Ecosystem integrity - habitat value and biodiversity								
To improve and maintain the habitat value and associated biodiversity of the area.	Enhance structural diversity of vegetation.	Improve and increase the extent and type of habitats of the creek, so that diversity of fauna and flora of respective habitats is enhanced.		Short term. (Fully completed in conjunction with Stage 3.)	High	To be determined from total Stage 3 budget (\$770,000) and available Council funds	WC, CCL	C2311
		Maintain established habitat diversity.	Prevent weeds and exotics infestation through regular maintenance.	Long term. (Ongoing.)	High		WC, CCL	C2312
	Increase the extent of vegetation.	Undertake replacement with and re-establishment of native flora species.	Plant macrophytes in disturbed areas of the creek.	Short term. (Fully completed in conjunction with Stage 3.)	High		WC, CCL	C2321
		Provide a wildlife corridor between the coast and Harbord Road.		Plant trees and shrubs along the alignment of Greendale Creek.	Short term. (Fully completed in conjunction with Stage 3.)		High	WC, CCL
	Improve the habitat diversity on the site by encouraging greater involvement of the community in native revegetation and landscaping efforts.	Enhance community awareness of importance of native vegetation.		Long term. (Ongoing.)	Medium		WC, CCL	C2341
		Undertake replacement with and re-establishment of native flora species.	Plant macrophytes in disturbed areas around the lagoon margin.	Short term. (Fully completed in conjunction with Stage 3.)	High	WC, CCL	C2342	
		Remove and control exotic plant species in and around Greendale Creek.		Long term. (Ongoing.)	Medium	WC, CCL	C2343	
	Ensure that rehabilitation measures do not impact adversely on flora and fauna	Monitor flora and fauna communities pre and post rehabilitation measures		Long term (Ongoing)	Medium	To be determined from \$10,000 budget, staff costs and available Council funds	WC, CCL	C2344

Table 1. Management Schedule of Creek Area								
Objective	Strategy	Action	Detail	Status/ Implementation Schedule	Priority	Cost	Responsibility	Code
Public Amenity - aesthetic quality								
Ecosystem Integrity - habitat value and biodiversity								
To improve the aesthetic value of the creek and environs.	Implementation of the John Fisher Park Plan of Management with consideration of options as detailed in the Greendale Creek Rehabilitation Project Statement of Enviromental Effects (PB&P 1994b).	Re-establish a landscape character reflective of the original coastline.	Emphasise the use of natives.	Short term. (Fully completed in conjunction with Stage 3.)	Medium	To be determined from maintenance budget	WC	C2411
			Use exotic feature trees where considered appropriate to maintain historical and cultural character of the Northern Beaches area.	Short term. (Fully completed in conjunction with Stage 3.)	Medium	To be determined from total Stage 3 budget (\$770,000)	WC	C2412
Public Amenity - all components								
To improve amenity of the creek environment.	Implementation of the John Fisher Park Plan of Management with consideration of options as detailed in the Greendale Creek Rehabilitation Project Statement of Enviromental Effects (PB&P 1994b).	Improve the range of opportunities available for informal recreation.	Provide sufficient shade and wind protection to ensure comfortable settings are established for the enjoyment of the widest range of people.	Short term. (Fully completed in conjunction with Stage 3.)	Medium	To be determined from maintenance budget	WC	C2511
		Improve vegetation around sport fields.	Provide shade and wind protection for sport spectators.	Short term. (Fully completed in conjunction with Stage 3.)	Low		WC	C2512
Public Amenity - site planning and design and land use								
To maintain John Fisher Park and environs as a recreational and sporting centre.	Implementation of the John Fisher Park Plan of Management with consideration of options as detailed in the Greendale Creek Rehabilitation Project Statement of Enviromental Effects (PB&P 1994b).	Maintain existing sporting facilities.		Long term. (Ongoing.)	High	Staff costs	WC	C2611
		Assess future sporting and recreational developments' compliance to John Fisher Park Plan and this estuary management plan.		Long term. (Ongoing.)	Low		WC	C2612
Public Health and Safety								
To improve safety of users.	Implementation of the John Fisher Park Plan of Management with consideration of options as detailed in the Greendale Creek Rehabilitation Project Statement of Enviromental Effects (PB&P 1994b).	Provide a safe pedestrian connection to bike trails.		Short term. (Fully completed in conjunction with Stage 3.)	Medium	To be determined from maintenance budget	WC	C2711
		Remove potentially dangerous objects from surface of soil.		Short term. (Fully completed in conjunction with Stage 3.)	High	To be determined from total Stage 3 budget (\$770,000)	WC	C2712

Table 2. Management Schedule Lagoon Area

Objective	Strategy	Action	Detail	Status/ Implementation Schedule	Priority	Cost	Responsibility	Code
Ecosystem integrity - habitat value and biodiversity								
To improve and maintain the habitat value and associated biodiversity of the area.	Enhance structural diversity of vegetation.	Improve and increase the extent and type of habitats of the lagoon, so that diversity of fauna and flora of respective habitats is enhanced.		Short to medium term.	High	\$25000 and staff costs	WC, CCL	L1611
		Retain existing delta downstream of the footbridge and submerged island for bird use.		Long term. (Ongoing.)	High		WC	L1612
	Avoid any destabilisation of existing aquatic vegetation and foreshores.	Ensure that future rehabilitation works do not impact on the lagoon margins.		Short to medium term.	High		WC	L1621
	Increase the extent of vegetation to provide a wildlife corridor between the coast and Harbord Road.	Undertake replacement and re-establishment of native flora species.	Plant native trees and shrubs around the lagoon margin.	Short to medium term.	Medium		WC,CCL	L1631
			Plant macrophytes in disturbed areas around the lagoon margin.	Short to medium term.	Medium		WC,CCL	L1632
			Extend vegetation to margins of the reserve.	Short to medium term.	Medium		WC,CCL	L1633
	Improve the habitat diversity on the site.	Enhance community awareness of importance of native vegetation.	Involve community in native planting programs.	Short to medium term.	Medium		WC,CCL	L1641
		Remove and control exotic plant species in and around the lagoon and its tributaries.		Long term. (Ongoing.)	Medium		WC,CCL	L1642
Public Amenity - site planning and design								
To develop area to cater for a range of informal recreation activities which appeal to a wide range of people.	Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Improve the range of opportunities available for informal recreation.	Provide sufficient shade and wind protection to ensure comfortable settings are established for the enjoyment of the widest range of people.	Short to medium term.	High	To be determined from rehabilitation budget	WC	L1711
			Form an elevated ridge to provide wind protection for users of the flatter areas adjacent to the lagoon entrance.	Short to medium term.	Medium		WC	L1712
		Assess future sporting and recreational developments' compliance to Estuary Managmenet Plan.		Long term. (Ongoing.)	Low		WC	L1713

Table 3. Management Schedule Catchment Area

Objective	Strategy	Action	Detail	Status/ Implementation Schedule	Priority	Cost	Responsibility	Code
Ecosystem Integrity - all components								
To increase the community's awareness and understanding of the processes of Curl Curl Lagoon.	Ensure the community and stakeholders' expectations of rehabilitation efforts are in line with appropriate time frames.	Clearly communicate expected outcomes of any rehabilitation/ environmental programs conducted in an around the lagoon to minimise the risk of misalignment of community expectations.		Short to medium term.	High	Staff costs	WC	A2811
Ecosystem Integrity - water quality and air quality								
To improve the water quality in terms of managing inputs of sediments, nutrients and other contaminants.	Initiate improvements in sewerage system management in the Curl Curl Lagoon catchment.	Increase detention in sewage pumping station (SPS) 286 (North Curl Curl) to eliminate overflows into the lagoon.		Complete (1998).	NA	NA	SWC	A2911
		Conduct hydraulic modifications on SPS 127 (Park Street) to minimise potential for overflows into the lagoon.		Complete (1998).	NA	NA	SWC	A2912
		Conduct sewer lining work in North Curl Curl carrier to prevent exfiltration and undesigned overflows into catchment.		Completed.	NA	NA	SWC	A2913
		Adjust weir heights to increase capacity of sewerage system.		Completed.	NA	NA	SWC	A2914
	Continue close liaison with Sydney Water representatives regarding the improvements to the sewerage system in the Curl Curl Lagoon Catchment.	Produce and maintain an inventory of sewerage overflow points within the system in conjunction with Sydney Water.	Upon finalisation of pollution reduction programs for sewerage system, determine improvement works that have been established for Curl Curl Lagoon catchment.	Short term.	Medium	NA	SWC, WC	A2921
	Assess the level of possible pollution sources to the Curl Curl system.	Conduct an environmental audit in the Brookvale Industrial Estate.		Completed (1995).	NA	Staff costs	WC	A2931
	Operate a continuous program of auditing local companies for compliance with environmental law in the field of stormwater protection.	Audits carried out by Catchment Liaison Officer and Silt and Sediment Control Officer.	Regular field inspections and audits are used to ensure compliance with relevant legislation and building practices.	Long term. (Ongoing.)	High	Staff costs	WC	A2932

Objective	Strategy	Action	Detail	Status/ Implementation Schedule	Priority	Cost	Responsibility	Code
Ecosystem Integrity - all components								
To determine or refine desired rehabilitation, short term and long term objectives for the Curl Curl Lagoon system.	Improve understanding of the processes at work in the Curl Curl Lagoon system.	Adopt module 1 of the Curl Curl Lagoon Ecological Monitoring Program.	Determine baseline status of system in terms of ecological health and integrity (minimum requirements and long term monitoring program).	Medium term.	High	To be determined from \$10,000 budget, staff costs + available council funds	WC	A3011
			Review monitoring results.	Long term. (Ongoing.)	High		WC	A3012
			Determine action required to mediate or mitigate impacts.	Long term. (Ongoing.)	High		WC	A3013
			Reassess relevant management procedure and modify accordingly.	Long term. (Ongoing.)	Medium		WC	A3014
	Determine the performance of management actions (including rehabilitation measures) undertaken in the Curl Curl Lagoon system (short term monitoring program module).	Adopt module 2 of the Curl Curl Lagoon Ecological Monitoring Program.	Monitor the depth of the lagoon and creek to provide information on the rate of sediment infilling during and after completion of rehabilitation works.	Long term. (Ongoing.)	Medium	To be determined from \$10,000 budget + staff costs	WC	A3021
				Long term. (Ongoing.)	Medium		WC	A3022
	Determine the impacts of acute incidents/construction related activities and relevant necessary actions.	Adopt module 3 of the Curl Curl Lagoon Ecological Monitoring Program.	Monitor relevant parameters at appropriate time.	Long term. (Ongoing.)	Medium	To be determined from \$10,000 budget, staff costs + available council funds	WC	A3031
			Review monitoring results.	Long term. (Ongoing.)	Medium		WC	A3032
			Determine action required to mediate or mitigate impacts.	Long term. (Ongoing.)	Medium		WC	A3033
			Reassess relevant management procedure and modify accordingly.	Long term. (Ongoing.)	Medium		WC	A3034
Table 4. Management Schedule Entrance Area								
Objective	Strategy	Action	Detail	Status/ Implementation Schedule	Priority	Cost	Responsibility	Code
Ecosystem Integrity - all components								
To improve amenity of the lagoon environment.	Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Provide a path parallel to the beach along dune for ocean views.		Short to medium term.	Medium	To be determined from rehabilitation budget	WC	E1811
Ecosystem Integrity - water quality and air quality								
To develop area to cater for a range of informal recreation activities which appeal to a wide range of people.		Modify the slope of grass banks to allow passive activities and access to the water's edge.	Landscape meadow area to provide suitable informal recreation space.	Short to medium term.	Medium	To be determined from rehabilitation budget	WC	E1911

Table 5. Management Schedule Lagoon and Entrance Area

Objective	Strategy	Action	Detail	Status/ Implementation Schedule	Priority	Cost	Responsibility	Code
Ecosystem Integrity - water quality								
To provide strategies for mitigation, control and/or treatment of pollutant sources into Curl Curl Lagoon.	Development of Greendale Creek and Curl Curl Lagoon Stormwater Treatment and Management Plan.	Inventory of stormwater outlets into waterways and development of management strategy.		Complete.	NA	NA	WC	LE111
		Priority schedule of stormwater outlets requiring treatment in line with planned rehabilitation measures.		Complete.	NA		WC	LE112
		Undertake high priority treatment and upgrade measures as detailed in PB&P (1997).		Complete in conjunction with Stage 3 rehabilitation works.	High		WC	LE113
	Proceed with preferred water quality improvement measures as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Completion of remaining treatment measures as detailed in PB&P (1997).		Long term and in conjunction with Stage 4 rehabilitation work as required. (Ongoing.)	High	NA (Major open drain options cost between \$12,000 and \$100,000)	WC, SWC	LE121
To improve the water quality in terms of managing inputs of sediments, nutrilent and other contaminants.	Manage land filled areas adjacent to the lagoon in order to minimise detrimental effects of stormwater, sewerage overflows and run-off on lagoon ecosystem.	Monitor effects of leachate inputs into waterways with respect to ongoing and planned uses.		Long term. (Ongoing.)	High	To be determined from monitoring budget (\$10,000 per annum) and available Council Funds	WC, CCL	LE211
	Continue close liason with Sydney Water representatives regarding the improvements to the sewerage system in the Curl Curl Lagoon Catchment.	Produce and maintain an inventory of sewerage overflow points within the system in conjunction with Sydney Water.		Long term. (Ongoing.)	High	Staff costs	WC, SWC	LE221
	Encourage "on-site" detention of stormwater to decrease the nutrient runoff.	Assess wetland types and their potential use within the Curl Curl catchment to minimise solid and dissolved contaminant inputs into the lagoon.		Long term. (Ongoing.)	Medium	To be determined from monitoring budget (\$10,000 per annum), available Council Funds and grant funding	WC, CCL	LE231
	Construct mini- wetland at Surf Road.		Completed (1996).	NA		WC, CCL	LE232	
	Assess performance of Surf Road mini-wetland.	Adopt the relevant monitoring module.	Long term. (Ongoing.)	Medium		WC, CCL	LE233	
Ecosystem Integrity - habitat value and biodiversity								
To improve and maintain the habitat value and associated biodiversity of the area.	Enhance structural diversity of vegetation.	Maintain established habitat diversity.	Prevent weeds and exotics infestation through regular maintenance.	Long term. (Ongoing.)	High	To be determined from revegetation budget, available Council Funds and grant funding	WC, CCL	LE311
	Enhance community awareness of importance of native vegetation.	Continue Council initiatives for community consultation.		Long term. (Ongoing.)	Medium		WC, CCL	LE321
		Coordinate education program with other organisations involved in revegetation.		Long term. (Ongoing.)	Low		WC, CCL	LE321
Ecosystem integrity - lagoon breakouts								
To enhance natural ecosystem integrity	Determine best-practice management options for the system, considering the completed rehabilitation works further upstream.	Determine desirable breakout regime for the lagoon system through appropriate studies and monitoring.	Adopt the relevant monitoring module.	Medium term. (Undertake prior to Stage 4.)	High	To be determined from monitoring budget (\$10,000), available Council Funds and grant funding	WC	LE411
		Review the current management procedure for lagoon breakout.	Ascertain flooding procedure for lagoon entrance incorporates relevant monitoring module.	Long term. (Ongoing.)	Medium		WC	LE412
		Prevent opening of lagoon by unnatural processes.	Develop informative pamphlets and erect signs.	Long term. (Ongoing.)	Low		WC	LE413
		Enhance community's understanding of impacts of breakout process.	Community consultation and workshops.	Long term. (Ongoing.)	Low		WC	LE414
Ecosystem Integrity - all components								
To improve ecological health of the system in terms of flow regime.	Rehabilitate the lagoon system to provide an environment in which desirable water regime can be sustained.	Determine desirable water regime for the lagoon system.	Adopt the relevant monitoring module.	Short to Medium term. (Undertake prior to Stage 4.)	High	To be determined from monitoring budget (\$10,000), available Council Funds and grant funding	WC	LE511
Ecosystem Integrity - water quality and sediment quality								
To improve ecological health of the system in terms of sediment quality.	Further investigate the option of removing contaminated lagoon and creek sediments via dredging.	Give further consideration to Stage 4 options in view of completed rehabilitation measures.		Short to Medium term. (Undertake prior to Stage 4.)	High		WC	LE611
		Prepare appropriate management plans of (including maps for) acid sulphate soils and contaminated sediments.		Short to Medium term. (Undertake prior to Stage 4.)	Medium		WC	LE612
		Adopt the relevant monitoring module for construction related activities.		Short to Medium term. (Undertake in conjunction with Stage 4.)	Medium		WC	LE613
Ecosystem Integrity - water quality								
To assess the effectiveness and limitations of the current water quality monitoring progam.	Conduct a review of available water quality data for Curl Curl Lagoon and catchment to determine future directions and management actions relating to lagoon system monitoring.	Complete the water quality review and ecological monitoring program study- currently being undertaken by AWT.		Short term. (To be completed 04/2000.)	NA	NA	WC	LE711
	Provide an assessment of the relative pressures on and the state of the creek and lagoon water quality.	Complete the water quality review and ecological monitoring program study- currently being undertaken by AWT.		Short term. (To be completed 04/2000.)	NA	NA	WC	LE721
	Develop a new monitoring program that improves the understanding of ecosystem processes, assesses the effectiveness of rehabilitation measures and facilitates management's decision making (for preventive and responsive measures).	Develop a modular monitoring program including a <i>minimal requirements</i> module and other monitoring options for management.	Ensure that the ecological monitoring program is cost-effective and includes budget flexibility.	Short term. (To be completed 04/2000.)	NA	NA	WC	LE731
			Ensure that the ecological monitoring program is consistent with current state and national ecological monitoring guidelines.	Short term. (To be completed 04/2000.)	NA	NA	WC	LE732
		Establish partnerships with other research organisations, government agencies and/ or educational institutions.	Refer to listing in Section 3.5 of the Estuary Management Plan. Keep up-to-date records of programs and deadlines for applications.	Long term. (Ongoing.)	Low	Staff costs	WC	LE733
Ecosystem Integrity/ Public Amenity - aesthetic quality								
To improve the aesthetic value of the lagoon.	Reduce the impact of gross pollution entering the lagoon via stormwater.	Organise Lagoon and John Fisher Park "Clean-up" days on a regular basis.	Coordinate local programs to remove gross pollutants with wider state and national "clean-up" and environmental programs.	Long term. (Ongoing.)	Medium	Staff costs	WC, CCL	LE811
Public Amenity - aesthetic quality								
Ecosystem Integrity - habitat value and biodiversity								
To improve the aesthetic value of the lagoon.	Proceed with preferred water quality improvement measures as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Review the effectiveness of existing community education programs about urban pollution reduction.	Modify programs as appropriate - focus on the Curl Curl Lagoon and environs. Encourage greater involvement of the community in native revegetation and landscaping efforts.	Long term. (Ongoing.)	Medium	Staff costs	WC, CCL	LE812
		Reestablish a landscape character reflective of the original coastline.	Emphasise the use of natives.	Short to medium term.	High	To be determined from rehabilitation budget	WC	LE911
			Construct a dune and adopt stabilisation measures as detailed in PB&P (1994a).	Short to medium term.	Medium		WC	LE912
			Investigate options for irrigation of the dune plantings.	Short to medium term.	Medium		WC	LE913
			Use exotic feature trees where considered appropriate to maintain historical and cultural character of the Northern Beaches area.	Short to medium term.	Low		WC	LE914

Table 5. Management Schedule Lagoon and Entrance Area								
Objective	Strategy	Action	Detail	Status/ Implementation Schedule	Priority	Cost	Responsibility	Code
Public Amenity - aesthetic quality and air quality								
To improve the aesthetic value of the lagoon.	Proceed with preferred water quality improvement measures as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Create a permanent water body.	Undertake relevant EIA process with careful consideration of issues outlined in Section 4.1 of this plan.		High	To be determined from rehabilitation budget	WC	LE1011
			Adopt relevant modules of monitoring program to assess performance of rehabilitation measures (including impacts associated with dredging and placement of settling ponds).	Short to medium term.	Medium		WC	LE1012
Public Amenity - all components								
To minimise any adverse impacts on the ocean views available from adjacent residences.	For revegetation strategies, adopt a planting design such that large shade and habitat forming trees minimise their obstruction of ocean views and maximise the potential for passive recreation.	Ensure revegetation actions are compliant with this objective.		Short to medium term.	High	To be determined from rehabilitation budget + staff costs	WC	LE1111
	Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Construct a dune as detailed in PB&P (1994a), the skyline of which would be lower than existing landforms.		Short to medium term.	High		WC	LE1121
Public Amenity - site planning and design								
To improve amenity of the lagoon environment.	Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Maintain existing parking facilities.		Short to medium term.	NA	To be determined from rehabilitation budget + staff costs	WC	LE1211
		Identify new opportunities for new formal parking areas.	Ensure that additional parking developments are compliant with other estuary management plan objectives.	Short to medium term.	Medium		WC	LE1212
		Provide additional kerbside parking along Griffin Road.	Ensure that additional parking developments are compliant with other estuary management plan objectives and local traffic committee policy.	Short to medium term.	NA		WC	LE1213
Public Amenity - site planning and design and land use								
To maintain John Fisher Park and environs as a recreational and sporting centre.	Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Maintain existing sporting facilities.		Short to medium term.	High	To be determined from rehabilitation budget + staff costs	WC	LE1311
		Ensure that future land use is complimentary with existing uses.	Provide children's playground and associated pathways south-east of the Curl Curl Youth Centre	Long term. (Ongoing.)	Medium		WC	LE1312
			Plant shrubs and trees around playground for shelter and shade.	Short to medium term.	Medium		WC	LE1313
Public Amenity - site planning and design								
To develop area to cater for a range of informal recreation activities which appeal to a wide range of people.	Enhance structural diversity of vegetation and its extent.	Plant trees along Abbott Road and Griffin Road.		Short to medium term.	High	To be determined from rehabilitation budget + staff costs	WC	LE1411
		Create vegetative buffer zone between property boundaries and southern edge of reserve.		Short to medium term.	High		WC	LE1412
	Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Enhance amenity through construction/ installation of recreational features.	Provide pedestrian/ cyclist path on southern side of lagoon between Park Street footbridge and Griffin Road.	Short to medium term.	Medium		WC	LE1421
			Construct viewing alcoves along the southern shore of the lagoon.	Short to medium term.	Medium		WC	LE1422
			Include feature tree planting of native species to highlight alcove locations.	Short to medium term.	Medium		WC	LE1423
			Provide roosting poles in the lagoon to attract larger bird species toward viewing alcoves.	Short to medium term.	Medium		WC	LE1424
			Addition and improvement of picnicking facilities.	Short to medium term.	Medium		WC	LE1425
Public Health and Safety/ Public Amenity - site planning and design								
To improve safety of users.	Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Provide a safe pedestrian connection between the two parts of the reserve (across Griffin Rd) and safe bike trails.		Short to medium term.	High	To be determined from rehabilitation budget + staff costs	WC	LE1511
		Remove potentially dangerous objects from surface of soil.		Short to medium term.	High		WC	LE1512
		Reduce steep and eroding slopes of breakout channel.		Short to medium term.	High		WC	LE1513
		Remove rubbish that becomes exposed along the margins. Prevent rubbish from entering (and polluting) the channel.		Short to medium term.	High		WC	LE1514

Table 6. High Priority Management Schedule for Curl Curl Lagoon

Strategy	Action	Detail	Status/ Implementation Schedule	Cost	Responsibility	High Priority Code	Code
STAGE 4 OF THE REHABILITATION PROCESS							
Determine the best-practice management options for the system.	Further investigate the option of removing contaminated lagoon sediments via dredging.	Give further consideration to Stage 4 options in view of completed (Stage 3) rehabilitation measures upstream of lagoon in Greendale Creek.	Short to Medium term. (Undertake prior to Stage 4.)	To be determined from rehabilitation budget	WC	HP1	LE611
	Determine desirable breakout regime for the lagoon system through appropriate studies and monitoring.	Monitor for changes in aquatic communities post Stage 3 rehabilitation works. To define 'desirable', liaise with relevant State and Commonwealth bodies such as Fisheries and DLWC for advice.	Short to Medium term. (Undertake prior to Stage 4.)	To be determined from monitoring budget (\$10,000), available Council Funds and grant funding	WC	HP2	LE411
	Determine desirable water regime for the lagoon system.		Short to Medium term. (Undertake prior to Stage 4.)	To be determined from monitoring budget (\$10,000), available Council Funds and grant funding	WC	HP3	LE511
Rehabilitate the lagoon system to provide an environment in which desirable water regime can be sustained.	Reassess design details for Stage 4 works.	Create a permanent water body. Retain existing delta and submerged island for bird use.	Short to Medium term.	To be determined from rehabilitation budget	WC	HP4	LE1011, LE1612
Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).		Construct a dune as detailed in PB&P (1994a), the skyline of which would be lower than existing landforms.	Short to Medium term.	To be determined from rehabilitation budget	WC	HP5	LE1121, LE1612
	Remove contaminated sediments from the lagoon.	If dredging is considered a viable and desired option as a result of actions LE411, LE511 and LE611, undertake step-by-step action plan (Figure 4) to progress Stage 4 works.	Short to Medium term.	To be determined from rehabilitation budget	WC	HP6	LE611
WATER QUALITY							
Ensure ongoing efficient operation of stormwater treatment system.	Carry out the upgrade and treatment measures detailed in the Greendale Creek and Curl Lagoon Stormwater Management Plan.	Undertake high priority treatment and upgrade measures as detailed in PB&P (1997).	Complete in conjunction with Stage 3 and Stage 4 rehabilitation works.	To be determined from rehabilitation budget	WC	HP7	LE113, LE121
Manage land filled/sediment disposal areas adjacent to the lagoon in order to minimise detrimental effects of stormwater, sewerage overflows and run-off on lagoon ecosystem.	Monitor effects of leachate inputs into waterways with respect to ongoing and planned uses.	Monitor performance of Surf Road mini-wetland in improving water quality	Long term. (Ongoing.)	To be determined from monitoring budget (\$10,000 per annum) and available Council Funds	WC, CCL	HP8	LE211, LE233
		Upon completion of Stage 3 works, determine water quality impacts of leachate from recent sediment disposal areas (e.g. Reub Hudson Oval) using monitoring data.	Short to Medium term. (Undertake prior to Stage 4.)		WC	HP9	
	Following the determination of impacts from leachate on water quality, evaluate potential management options.	Upon completion of Stage 3 works, determine water quality impacts of leachate from historic land fill areas (e.g. lagoon and dune foreshore) using monitoring data.	Short to Medium term. (Undertake prior to Stage 4.)		WC	HP10	
		Assess viability of management options proposed by J.H. & E.S. Laxton Environmental Consultants (letter from Laxton to Hedge, 18 March 2000).	Short to Medium term. (Undertake prior to Stage 4.)		WC	HP11	
Continue close liaison with Sydney Water representatives regarding the improvements to the sewerage system in the Curl Lagoon Catchment.	Produce and maintain an inventory of sewerage overflow points within the system in conjunction with Sydney Water.	Assess impacts of sewerage overflows using data collected as part of monitoring program. Use data outcomes as basis for negotiation with Sydney Water.	Long term. (Ongoing.)	Staff costs	WC, SWC	HP12	LE221
AMENITIES							
Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Maintain existing parking facilities.	Assess any proposal for modification of existing parking facilities in accordance with the objectives of this plan and plans for adjacent areas.	Short to medium term.	To be determined from rehabilitation budget + staff costs	WC	HP13	LE1211
	Identify new opportunities for new formal parking areas.	Plant trees around carpark to provide more shade and protection.	Short to medium term.		WC	HP14	
	Provide additional kerbside parking along Griffin Road.	Ensure that additional parking developments are compliant with estuary management plan objectives.	Short to medium term.		WC	HP15	LE1212
	Maintain existing sporting facilities.	Ensure that additional parking developments are compliant with other estuary management plan objectives and local traffic committee policy.	Short to medium term.		WC	HP16	LE1213
	Provide a safe pedestrian connection between the two parts of the reserve (across Griffin Rd) and safe bike trails.	Assess any proposal for modification of existing facilities in accordance with the objectives of this plan and plans for adjacent areas.	Short to medium term.		WC	HP17	LE1311
	Remove potentially dangerous objects from surface of soil.	Determine the appropriate staging of these works in relation to other major Stage 4 works proposed.	Short to medium term.		WC	HP18	LE1511
	Reduce steep and eroding slopes of breakout channel.		Short to medium term.		WC	HP19	LE1512
			Short to medium term.		WC	HP20	LE1513

Table 6. High Priority Management Schedule for Curl Curl Lagoon

Strategy	Action	Detail	Status/ Implementation Schedule	Cost	Responsibility	High Priority Code	Code
LANDSCAPING AND REVEGETATION							
Enhance structural diversity of vegetation.	Maintain established habitat diversity.	Prevent weeds and exotics infestation through regular maintenance. Determine specific areas that require immediate attention and prioritise these. Prepare an implementation schedule for weed removal. In addition to regular Council maintenance works, develop a roster system for different community groups to be involved in each scheduled event.	Long term. (Ongoing.)	To be determined from revegetation budget, available Council Funds and grant funding	WC, CCL	HP21	LE311
		Establish low-growing hardy native species to aid in stabilisation of foreshore, and won't obstruct residents' ocean views.	Short to medium term.		WC	HP22	LE1121
Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Reestablish a landscape character reflective of the original coastline.	Emphasise the use of natives.	Short to medium term.	To be determined from rehabilitation budget	WC	HP23	LE911
For revegetation strategies, adopt a planting design such that large shade and habitat forming trees minimise their obstruction of ocean views and maximise the potential for passive recreation.	Ensure revegetation actions are compliant with this objective.		Short to medium term.	To be determined from rehabilitation budget + staff costs	WC	HP24	LE1111
Enhance structural diversity of vegetation and its extent.	Plant trees along Abbott Road and Griffin Road.	Emphasise the use of natives and ensure compliance with other revegetation objectives in this plan.	Short to medium term.	To be determined from rehabilitation budget + staff costs	WC	HP25	LE1411
	Create vegetative buffer zone between property boundaries and southern edge of reserve.		Short to medium term.		WC	HP26	LE1412
	Improve and increase the extent and type of habitats of the lagoon, so that diversity of fauna and flora of respective habitats is enhanced.	Ensure that actions proposed are assessed in accordance with related objectives.	Short to medium term.		WC, CCL	HP27	L1611
Avoid any destabilisation of existing aquatic vegetation and foreshores.	Ensure that future rehabilitation works do not impact on the lagoon margins.	Assess potential impacts in relevant EIA process to be conducted for Stage 4 works (see Step-by-step Action Plan - Figure 3).	Short to medium term.		WC	HP28	L1621
Proceed with preferred site planning and design options as detailed in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (PB&P 1994a).	Improve the range of opportunities available for informal recreation.	Provide sufficient shade and wind protection to ensure comfortable settings are established for the enjoyment of the widest range of people.	Short to medium term.	To be determined from rehabilitation budget	WC	HP29	E1911, L1711
JOINT COMMUNITY AND COUNCIL INITIATIVES							
Ensure the community and stakeholders' expectations of rehabilitation efforts are in line with appropriate time frames.	Clearly communicate expected outcomes of any rehabilitation/ environmental programs conducted in and around the lagoon to minimise the risk of misalignment of community expectations.	Send regular newsletters with each new development/proposed activities for the lagoon and surrounds. Communicate realistic time frames for completion of works and associated manifestation of positive environmental effects.	Short to medium term.	Staff costs	WC	HP30	A2811
Operate a continuous program of auditing local companies for compliance with environmental law in the field of stormwater protection.	Audits carried out by Catchment Liaison Officer and Silt and Sediment Control Officer.	Regular field inspections and audits are used to ensure compliance with relevant legislation and building practices.	Long term. (Ongoing.)	Staff costs	WC	HP31	A2932
		Use information obtained from audits in conjunction with data collected from monitoring program to identify problem areas and mitigation measures.	Long term. (Ongoing.)		WC	HP32	
Improve understanding of the processes at work in the Curl Curl Lagoon system.	Adopt module 1 of the Curl Curl Lagoon Ecological Monitoring Program.	Determine baseline status of system in terms of ecological health and integrity (minimum requirements and long term monitoring program). Provide the community with the results through an information session.	Long term. (Ongoing.)	To be determined from \$10,000 budget, staff costs + available council funds	WC	HP33	A3011

Figure 3a. Strategic actions related to the management of Curl Curl Lagoon and Entrance

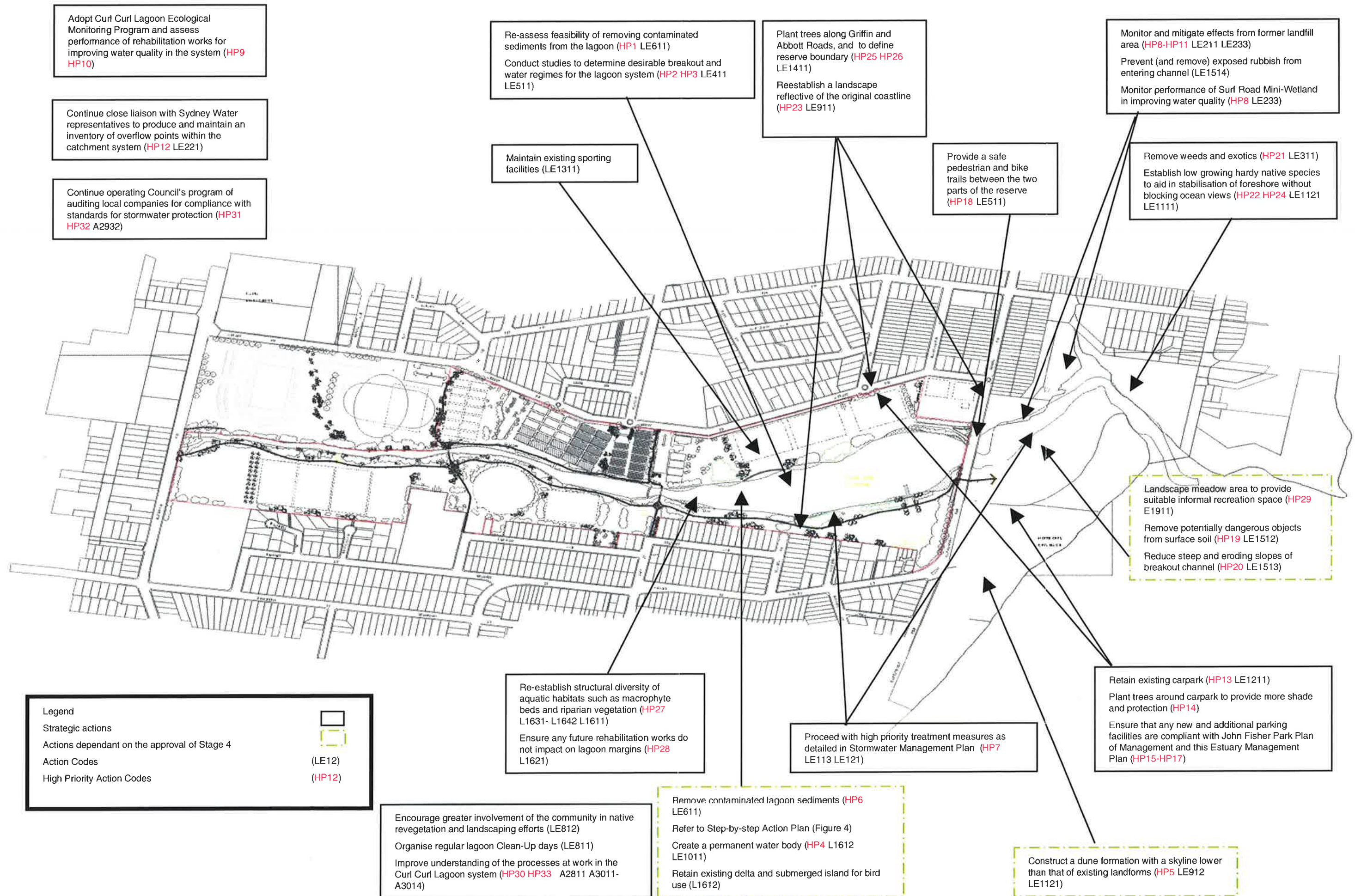
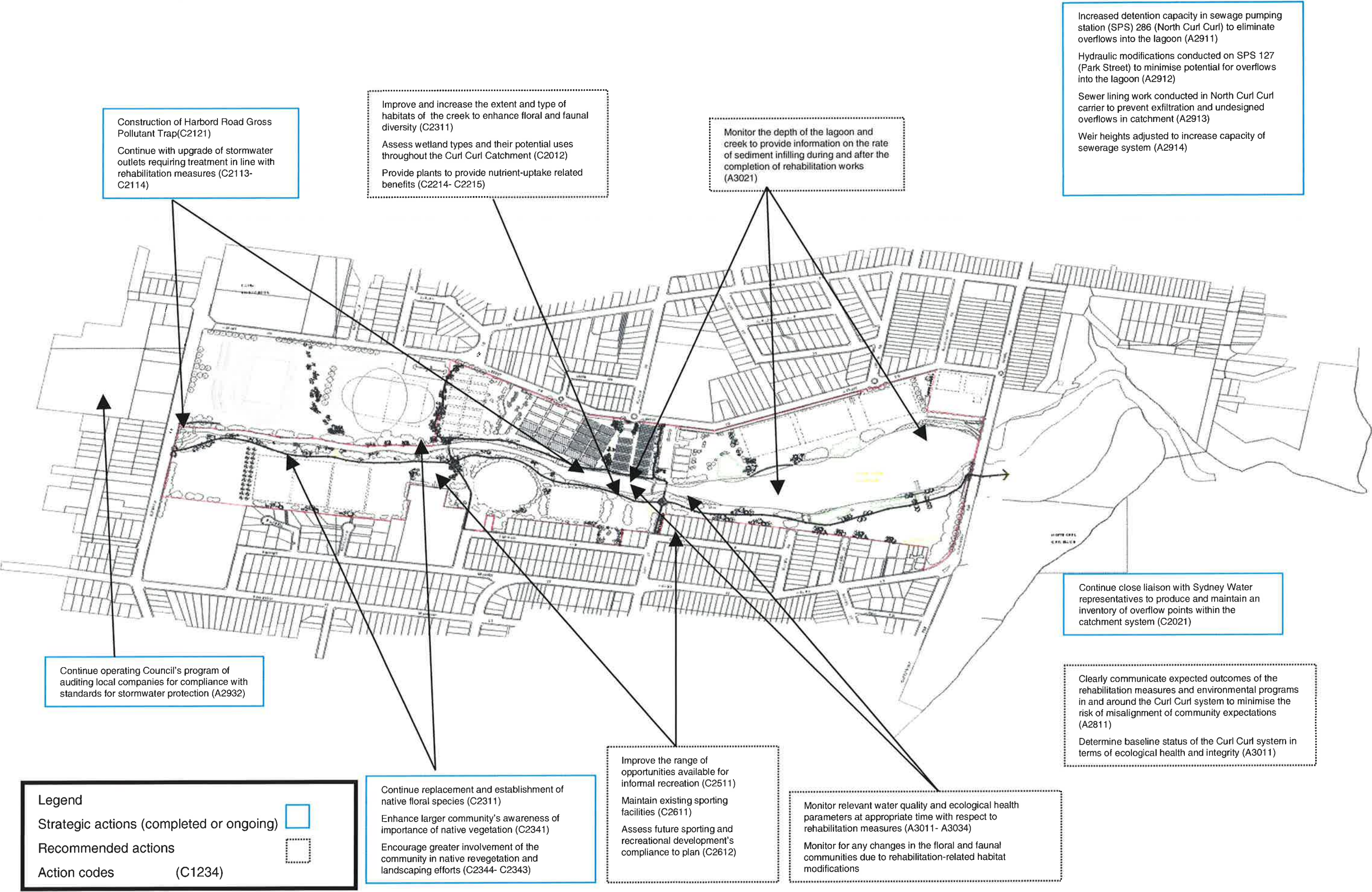


Figure 3b. Strategic actions related to the management of the Curl Curl Lagoon and Greendale Creek Catchment



3.4 Management Plan Monitoring and Review

In view of the history of Curl Curl Lagoon and the absence of specific estuarine process-related information, the Estuary Management Plan will need to be reviewed yearly in the medium term.

As outlined in the *Estuary Management Manual* (NSW Government 1992) monitoring is essential to ensure that management activities are having the desired effect on the ecosystem components and public amenities. Measurement of performance of the management plan is highly dependent on the adoption of the relevant monitoring program modules detailed in the concurrently developed draft *Curl Curl Lagoon Ecological Monitoring Program* (AWT 2000). These modules incorporate ongoing baseline monitoring, event and acute incident monitoring.

Review of the data obtained through monitoring might indicate that the plan requires modification, perhaps even the management objectives.

3.5 Potential Funding Sources and Associated Organisations

Funding for achieving management objectives and actions related to the health and functioning of estuaries can be obtained from a number of national and state government organisations. Among the many different initiatives, there are a number of programs that provide funding for which Council, either independently or as a member of a consortium, may apply.

Provided below is a listing of potential funding sources, which is by no means intended to be exhaustive. The web site addresses for the major “umbrella” organisations and their respective programs are included, for the purpose of easily accessing the most up-to-date contact numbers and specific funding priorities (including grant amounts and information on the projects that have received funding in previous rounds). In order to maximise their chances of securing funding for projects, Council and interested Community members should keep abreast of trends that determine estuarine health and research priorities and their relevance to the Curl Curl Lagoon ecosystem and catchment.

The listing of potential funding sources includes NSW-based organisations with a track record in research of estuarine issues. The formation of partnerships between such organisations and Council for certain projects may be sought.

Commonwealth organisations

Funding bodies in partnership with State Government organisations such as the EPA and the DLWC

National Heritage Trust (NHT)

(www.nht.gov.au/programs/coasts.html)

Community and Council Programs include:

- Landcare
- Rivercare
- Fisheries Action Program

Environment Australia (EA)

(www.environment.gov.au/marine/contacts.html)

The marine group provides funding through the NHT under the Coast and Clean Seas Program

- Clean Seas Program
- Coastal and Marine Planning Program
- Coastcare
- Coastal Monitoring and Vulnerability Assessment

State Government organisations

Department of Land and Water Conservation (DLWC)

(www.dlwc.nsw.gov.au)

Encourages Councils to initiate or further develop Catchment and Estuarine Management Committees

- Coastcare
- Waterwatch, Streamwatch, Waterweek, Waterwise
- Dunecare, Landcare, Rivercare (see NHT)
- Algal Management Initiative

Other Government Agencies and Universities

- Australian Museum
- UNSW, University of Sydney
- Macquarie University
- Southern Cross University

3.6 Legislative Considerations

Environmental and planning legislation prescribes that certain approval processes need to be undertaken for particular activities that have the potential to affect the environment. The legislation that is relevant to the actions outlined in this estuary management plan, as well as to potential future actions that might arise through review and update of the plan, is detailed in Table 7. In addition to the intended purpose of the legislation, the table provides details of approvals that are required under certain circumstances and for particular activities. Such approvals constitute permits, licences and applications for development consent.

As described in Table 7, development activities proposed for an area are partially directed by the relevant planning instruments. The planning instrument that covers the area within which Curl Curl Lagoon lies is the *Warringah Local Environment Plan 1985* (Warringah Council 1985). The most recent revision of this plan is in draft format – *Draft Warringah LEP 1999: A Draft Plan for Controlling Development in Warringah* (Warringah Council 1999). The *State Environmental Planning Policy (SEPP) No. 35 (Maintenance Dredging of Tidal Waterways)* is an additional planning instrument that is likely to be applicable to any dredging activities that might be proposed for the lagoon.

Planning instruments determine whether development activities are assessed under Part 4 or Part 5 of the *Environmental Planning and Assessment Act 1979*; Part 4 of the Act provides for activities that require consent and Part 5 provides for those for which consent is not required. Irrespective of the requirement for consent, the type of environmental impact assessment (EIA) that must be conducted for a proposed activity is based on the potential for that activity to have a significant impact on the environment. The extent of the impact of the activity, and hence the type of EIA required, can be assessed by following the process outlined in *Is an EIS Required?* (Department of Urban Affairs and Planning – DUAP - 1999). Further details and suggestions relating to this determination are provided later in this section.

Action Plan for Approvals for Stage 4 Works

A suggested step-by-step process to be followed to progress actions relating to Stage 4 rehabilitation of the lagoon (specifically dredging activities) is portrayed in Figure 4. Although the draft LEP has been recognised as a legal document, it has not yet been gazetted. In addition, liaison with various government departments has indicated that the application of SEPP No. 35 to dredging activities could be questionable (depending on whether Curl Curl Lagoon can be considered a “tidal waterway” as defined in the SEPP). Hence, several scenarios have been considered in the step-by-step action plan so that if and when dredging is initiated, the scenario and associated process that are most relevant can be adopted.

The step-by-step action plan detailed in this section is also referred to in Table 6, in association with details of the high priority actions for Curl Curl Lagoon.

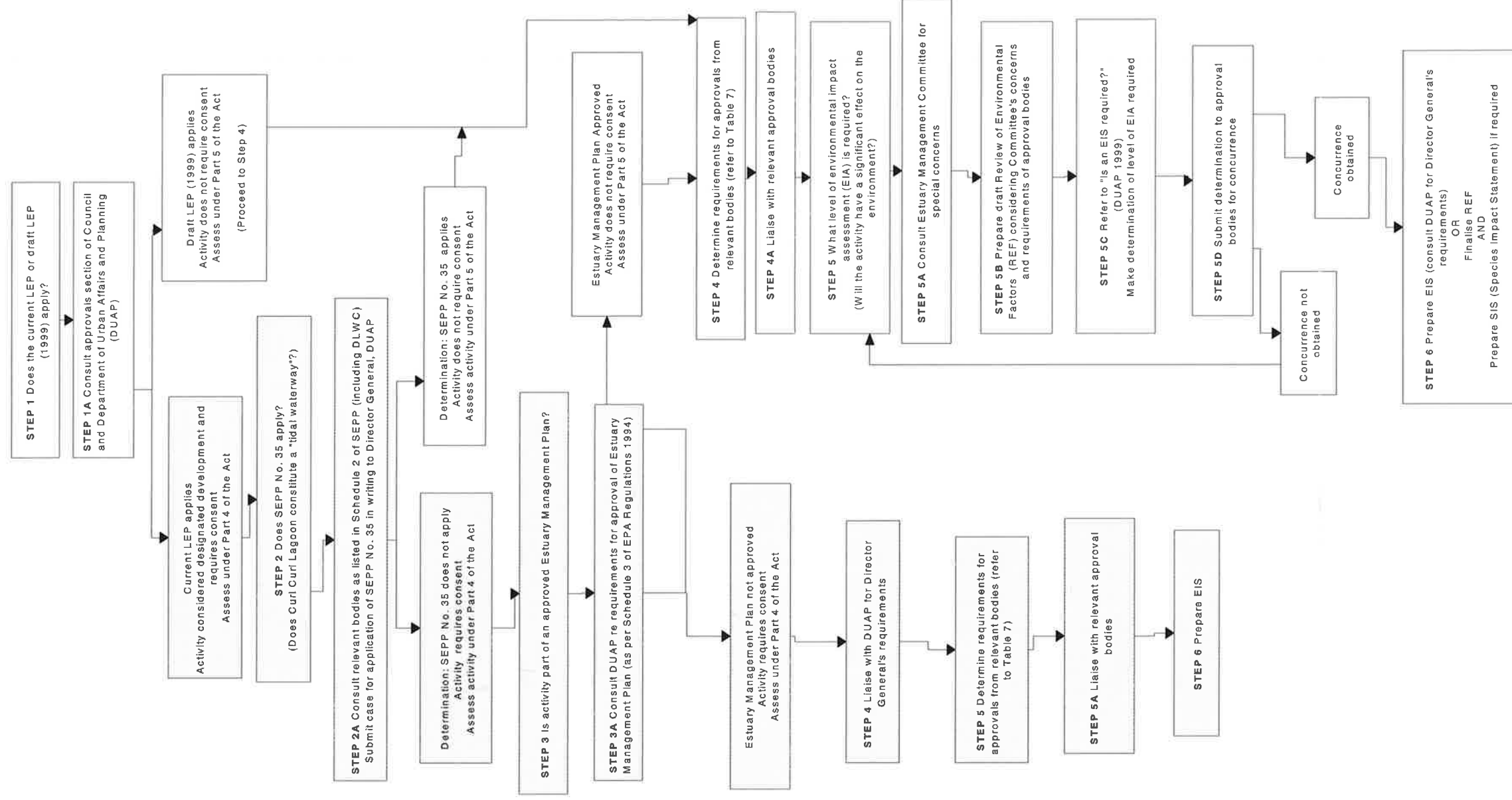
Table 7 Legislative Considerations and Required Approvals for Proposed Activities.

Act	Description	Responsible Authority	Consents/Approvals required
<i>Protection of the Environment Operations Act 1997</i>	This Act amalgamates a number of Acts and Regulations (including the Clean Waters Act and Regulation and the Pollution Control Act) relating to prevention and minimisation of pollution for air, water, waste, etc. It also sets out licensing requirements, offences and penalties.	EPA, Council	<p>Dredging of more than 30,000 m³ per year from the bed, banks or foreshore of any waters requires a licence from the EPA (as listed under Schedule 1 of the Act).</p> <p>Water protection licence is required if there is going to be pollution of waters associated with an activity. If a licence for dredging is required, the water protection licence conditions will be included with the dredging licence.</p>
<i>Environmental Planning and Assessment Act 1979 and Regulation</i>	<p>This Act institutes a system for environmental planning and assessment including approvals and environmental impact assessment (EIA) for proposed developments.</p> <p>Part 4 and Part 5 of the Act deem whether development consent is required for an activity.</p>	DUAP, Council	<p>Development activities in an area are partially directed by local Council's Local Environmental Plan (LEP) (under Part 4 of the Act). Warringah Council's current LEP lists dredging as an activity requiring consent. Hence, the activity would need to be considered under Part 4 of the EP&A Act. As there are (potentially) several approvals/licences required for dredging activities, the procedure of considering development consent in this case comes under "integrated development". Council must consult with other public authorities on their requirements for environmental protection licences, prior to granting development consent.</p> <p>State Environmental Planning Policy (SEPP) No. 35 might apply to the activity of dredging (see Figure 4). If so, the activity would not require consent and would need to be considered under Part 5 of the EP&A Act.</p> <p>In addition, under Schedule 3 of the EP&A Regulation 1994, dredging activities carried out as part of an approved Estuary Management Plan are exempted from requiring development consent. If so, the activities would need to be considered under Part 5 of the EP&A Act.</p> <p>Warringah Council's draft LEP 1999 is under consideration. The current draft LEP does not require consent for maintenance dredging. If the draft LEP is in effect at the time that dredging activities are initiated, consent would not be required and the activity would need to be considered under Part 5 of the EP&A Act.</p>

Table 7 (continued) Legislative Considerations and Required Approvals for Proposed Activities.

Act	Description	Responsible Authority	Consents/Approvals required
<i>National Parks and Wildlife Act 1974 and Regulation</i>	This Act provides for the protection of all native flora and fauna, and Aboriginal sites and relics.	NPWS	It is necessary to obtain a licence to take/kill fauna, picking/trimming/removing native vegetation or damaging/defacing/removing Aboriginal relics or places.
<i>Threatened Species Conservation Act 1995</i>	This Act provides for the protection of all threatened plants and animals, to conserve biological diversity and promote ecologically sustainable development (ESD). The Act integrates the assessment of a development or activity into the development control process.	NPWS	Consent is required for activities that are deemed to have the potential for significant impact on threatened species, populations, ecological communities or their habitat.
<i>Rivers and Foreshores Improvement Act 1948</i>	The Act relates to the prevention of erosion of land by waters and to control activities within 40 metres of rivers, lakes and foreshores.	DLWC	<p>A permit is required to remove or excavate material within 40 metres of rivers, lakes and foreshores or to cause any change to a riverbed or banks.</p> <p>Although Council is exempt from requiring a permit, liaison with DLWC to obtain their conditions should be conducted as a matter of environmental due diligence.</p>
<i>Soil Conservation Act 1938</i>	This Act relates to soil conservation, erosion mitigation and protection of waterways and some habitats.	DLWC	Under this Act it is necessary to obtain a permit to lop/remove any tree/shrub on land steeper than 18 degrees or within 20 metres of a prescribed stream/lake or environmentally sensitive land. If permits are required, they must be obtained prior to any works commencing.
<i>NSW Fisheries Management Act 1994</i>	This Act provides for the protection, conservation and management of fisheries resources.	NSW Fisheries	<p>It is an offence to dredge or reclaim land in any waters in NSW without a permit from NSW Fisheries or another NSW government department.</p> <p>Permits are required for removal or damage to marine and estuarine vegetation.</p> <p>Permits are required for removal or damage to marine and estuarine habitat.</p>
<i>Waste Minimisation and Management Act 1995</i>	This Act regulates the management and licensing of waste activities. A primary objective of the Act is to encourage the reduction and reuse of waste for disposal.	EPA	A permit may be required under the Act depending on the type of material for disposal and the proposed receiving location.

Figure 4 Step-by-step Action Plan for Stage 4 Works



4 Community Consultation

4.1 Management Plan Consultation Process

Draft Management Plan Development

Progress with the development of the draft Estuary Management Plan (along with that of the water quality review and ecological monitoring program development) was presented to the Dee Why Lagoon and Curl Curl Lagoon Estuary Management Committee at a meeting held in Warringah Council premises on 31 January 2000.

An additional meeting was held between Curl Curl Lagoon Friends Inc., Warringah Council and AWT prior to the submission of the draft Estuary Management Plan (and the draft Ecological Monitoring Program Report - AWT 2000). The purpose of this meeting was to discuss issues of ongoing concern and interest to Curl Curl Lagoon Friends Inc. with respect to the lagoon's rehabilitation and management, which were taken into consideration in the preparation of this plan (refer to Section 3.1 – Associated Stakeholder Issues).

Public Exhibition of Draft Management Plan

The draft Curl Curl Lagoon Estuary Management Plan and Ecological Monitoring Report were on public exhibition from 19th of February to 18th of March 2000 in Warringah Council Civic Centre. The exhibition was advertised in the Mayors Message and requested community input to, and comment on, the draft documents.

A letter box drop to the Curl Curl Catchment was also undertaken requesting interested stakeholders reply to Council if they wanted to receive further information on the development and public exhibition of the draft documents. Those who replied were sent a second newsletter alerting of the public exhibition of the drafts.

Community comments, received during the public exhibition period are summarised below. Copies of the letters received from community members are included in Appendix 1.

It was determined following the submission to Council from the Curl Curl Lagoon Friends and several meetings between Council, community representatives and the consultants that a "Step-by-Step" detailed action plan was required. This action plan, in effect a separate management schedule of the high priority and short term management actions, would satisfy the Curl Curl Lagoon Friend's request for a document specifically covering the proposed "Stage 4" (PB&P 1994a) rehabilitation project activities.

Ongoing Consultation

Council will continue to inform the community of developments pertaining to the Curl Curl Lagoon system through a variety of community consultation processes including the distribution of newsletters and the organisation of information sessions and workshops. Council will ensure that there are many opportunities for community members and stakeholder groups to provide their input into the planning decisions, developments and actions related to the rehabilitation of the Curl Curl Lagoon system.

5 References

- Australian Water Technologies, 2000. *Curl Curl Lagoon Ecological Monitoring Report*. Draft report prepared for Warringah Council, West Ryde.
- Department of Urban Affairs and Planning (DUAP), 1999. *Is an EIS required?* DUAP, New South Wales.
- New South Wales Government, 1992. *Estuary Management Manual*. New South Wales Government, New South Wales.
- Patterson Britton & Partners, 1992. *Curl Curl Lagoon Rehabilitation Study*. Report prepared for Warringah Council, North Sydney.
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- Patterson Britton and Partners, 1999. *Northern Beaches Stormwater Management Plan*. Report prepared for Warringah Council.
- Warringah Council, 1985. *Warringah LEP 1985*.
- Warringah Council, 1996. *Abbot Road Land Plan of Management*. Report prepared by Manidis Roberts Consultants for Warringah Council, Sydney.
- Warringah Council, 1998a. *John Fisher Park and Environs Plan of Management*. Report prepared by Gutteridge, Haskins & Davey Ltd in conjunction with Warringah Council Policy and Planning Unit.
- Warringah Council, 1998b. *Geographic Plan of Management for Coastal Community Lands*. Report prepared by Warringah Council, Sydney.
- Warringah Council, 1998c. *Recreation Strategy for Warringah's Beaches and Coastal Open Space*. Report prepared by Warringah Council, Sydney.
- Warringah Council, 1999. *Draft Warringah LEP 1999: A Draft Plan for Controlling Development in Warringah*.

Appendix 1 Public submissions



Scot Hedge
Warringah Council
Civic Centre
725 Pittwater Rd
DEE WHY 2099

25 February 2000

Dear Scot

**Re Draft Curl Curl Lagoon Estuary Management Plan and
Ecological Monitoring Program**

Thank you for supplying copies of the above to enable our members to study in depth the Estuary Management Plan and Ecological Monitoring Program for Curl Curl Lagoon.

As the draft is studied in detail it becomes apparent that it is more a **REVIEW** document than a **PLAN OF ACTION**. The review reveals a great deal of rehabilitation work achieved by Council and Council should be congratulated for its continuous commitment to rehabilitate the Curl Curl Lagoon Estuary but now that we are approaching Stage 4 this Estuary Plan should be setting out the guidelines and actions required in clearly defined steps.

The main plan for Stage 4 is set out in detail in the Curl Curl Lagoon Rehabilitation Project Statement of Environmental Effects (July 1994) prepared by Patterson Britton and Partners. But does this document adequately cover the new regulations for Dredging, Acid Sulphate Management and Fisheries - if the requirements are fully covered by this document the Report should say so, if not the steps to be taken should be set out in an **ACTION PLAN**. (A summary of the Acts/Regulations should be included in the appendices to the Estuary Management Plan as discussed at our 7 February meeting with the Consultants)

All the requirements for Stage 4 such as surveys, tests, approvals should be set out with suitable references and guidelines to be used as a useful tool for the rehabilitation of Curl Curl Lagoon. We know that our members and the community would appreciate a **STEP BY STEP ACTION PLAN** to refer to during this important stage of the rehabilitation process.

Yours sincerely

Reg Paling

PRESIDENT

cc Cr Ruth Sutton, Cr Peter Forrest, Cr Phil Colman, Cr Kevin Smith, Cr Darren Jones
Dennis Corbett, Daniel Lovett, Mariell Davidson
Col Huntingdon



156092

Scot Hedge
Warringah Council
Civic Centre
725 Pittwater Rd
DEE WHY 2099



WARRINGAH COUNCIL	
REF TO	Scot Hedge
FILE WITH	
FILE NO	233. 002. 010.
- 7 MAR 2000	
SEEN BY	
REF TO	DATE
REPLY REQUIRED YES/NO	

6 March 2000

Dear Scot

**Re Draft Curl Curl Lagoon Estuary Management Plan and
Ecological Monitoring Program**

Further to our letter of the 27 February 2000 the Executive of the Curl Curl Lagoon Friends Inc wish to make this submission re the above. Our Executive have studied the two documents thoroughly and offer the following comments and suggestions for your consideration.

The document is a review and collation of existing work, however the planning contribution which could be expected from the brief, is absent. Curl Curl Lagoon Friends have been working for twenty (20) years to fulfil the vision of a rehabilitated Curl Curl Lagoon and now this document in its current form is *impotent* - it lacks the careful thought and preparation which is essential to transform the vision into a reality.

There are two important areas where we feel the document requires attention:

- 1) **There should be a detailed action plan, particularly for the short-term timespan in preparation for Stage 4.**
- 2) **"The Plan should also account for legislative and planning changes since 1994" (Brief 5.1).**

Both of the above inadequacies could be solved by the addition of a simple table of actions to be taken to prepare for Stage 4. The column headings could include Description, Start Date, Finish Date and Expected Cost.

A quick poll amongst our Executive identified the following list of topics which should be covered. We should stress that the list is not exhaustive, it is merely the steps that were obvious to us at the time.

- (1) The Action Plan could first set out a summary of requirements Council needs to adhere to under the new regulations for DREDGING - ACID SULPHATE SOILS - FISHERIES.
- (2) There could then be a list of requirements not covered by Statement of Environment Effects prepared by Patterson Britton & Partners 1994a
- (3) Actual requirements with a time frame and costing for surveys, maps, studies and approvals required under the headings of DREDGING - ACID SULPHATE SOILS - FISHERIES etc.
- (4) Other Government Departments that need to be consulted and or require approvals.
- (5) Development applications required
- (6) Owners consents.

The Statement of Environment Effects prepared by Patterson and Britton for Greendale Creek and Curl Curl Lagoon are impressive documents covering the requirements for dredging etc. that existed at the time. Now that we are fast approaching Stage 4 the studies and reports may be adequate -if so this Estuary Management Plan should say so. But a lot has happened since 1994 and an Estuary Management Plan prepared in the year 2000 should clearly state the requirements Council has to adhere to before starting Stage 4. All the relevant Acts/Regulations should be set out in

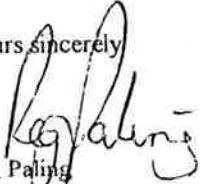
@ Why Curl Curl Lagoons Management Plan

the Estuary Management Plan and where possible extracts should be included either in the body of the Estuary Management Plan or in the Appendices.

We have studied the proposed Ecological Monitoring Program with interest. As promised at the Estuary Management meeting it is a modest program without bells and whistles. We recognise the need for monitoring before, during and after the rehabilitation of Greendale Creek and Curl Curl Lagoon but monitoring is only one aspect of the Estuary Management Plan.

We cannot stress too strongly the need for a simple **STEP BY STEP ACTION PLAN** for Stage 4 of the rehabilitation of Curl Curl Lagoon.

Yours sincerely

A handwritten signature in dark ink, appearing to read 'Reg Paling', written over the typed name.

Reg Paling
PRESIDENT

J.H. & E.S. Laxton Environmental Consultants P/L

A.C.N. 002 862 160

170 Warrimoo Ave, St Ives, NSW 2075
Ph: (02) 9449-7846 Fax: (02) 9983-0736

18th March 2000

Mr Scot Hedge
Coast and Estuaries
Warringah Council
Civic Centre Dee Why 2099

Dear Scot,

Review of Draft reports on Curl Curl Lagoon by AWT

After reading the draft report on Ecological Monitoring of Curl Curl Lagoon and scanning of the draft Management Plan I was left with the overwhelming impression that the author(s) did not understand how this lagoon functions as an ecological unit. I would direct their attention to my small report entitled :

Laxton, J.H. & E.S. 1997. *Gosford City Council. Management of small lagoons.* May 1997.

for an account of how Curl Curl Lagoon may have functioned before the advent of European settlement. Briefly, these small lagoons drained almost completely during a major rainfall event, closed again after 1 or a few days, and then commenced to refill. Water in the lagoon went through a prolonged metamorphosis until a distinctive brackish water ecology developed. The lagoon stayed closed for up to three years before emptying again. The cycle would then begin again.

Curl Curl Lagoon has been modified severely by the activities of man over the past 50 or more years. These changes include :

- Reducing the water surface area of the lagoon by filling the surrounding wetlands with municipal waste.
- Urbanising a large portion of the catchment.

The filling of wetlands and the destructive processes of urbanization has reduced the volume of water that the lagoon can hold. This means that quite small rainfall events can cause the lagoon to open and drain. In dry years Curl Curl Lagoon opens around 7 times a year and in wet years it open around 14 times a year. Once the ecological cycle took 3 years to complete. Now it may occur in less then a month. Unless this truncated ecological cycle of Curl Curl Lagoon is recognised and understood all attempts to devise estuary management plans and ecological monitoring programs are worthless.

As requested I will outline my views on the management of Curl Curl Lagoon. Water quality and hence ecology of this lagoon is affected by the following factors :

- The length of time that the lagoon is closed from coastal waters.

- Water and dissolved substances leaching from the old municipal rubbish tips lining the banks of the lagoon.
- Water currently draining from the catchment and from periodic overflows from the local sewerage reticulation system and the trunk sewers passing through the area.

Duration of Lagoon Closures

At present Curl Curl lagoon closures range from 3 to 6 weeks. Thus every 3 to 6 weeks salinity in the lagoon starts at 35 parts per thousand (seawater) and may reach almost zero (particularly in surface water). The lagoon may be highly stratified with respect to temperature, salinity, pH and dissolved oxygen when it is closed. When the lagoon opens components of the ecosystem that are pelagic (live in the water column) are expelled to the coastal waters. Benthic organisms (live in or on the sediment) over most of the lagoon bed are exposed to the sun for some days before the survivors are progressively covered by water of rapidly decreasing salinity. Also when the lagoon drains large flocks of birds arrive to feed on the exposed benthos and stranded fish and any invertebrates.

The duration of lagoon closures are a function of the surface area of the water of Curl Curl lagoon, the mean depth (between AHD and the top of the entrance sand bar) and the amount of rain that falls. The only way a management plan can lengthen the time that the lagoon is closed is to increase the surface area of the lagoon back to approaching its pre-European condition. This would entail eliminating the sports fields, excavating the old municipal tips and removing other developments that encroach on the former lagoon bed and surrounding wetlands. This is clearly not going to happen so no management plan can alter the frequency of lagoon openings and closings without undertaking extensive and complicated entrance works.

Effect of Old Tips on Water Quality

Water quality in Curl Curl Lagoon cannot be returned to close to its pre-European condition without tackling the leachate problem. As a goal of a management plan this is a do-able objective. The landfill sites along the shores of Curl Curl Lagoon are largely covered by sports fields. Stormwater falling on these fields penetrates the over-burden, saturates the garbage and eventually exits the landfill from diffuse points along the waters edge when the lagoon water level is lower than the water level in the fill. Water from the lagoon can also penetrate the landfill during periods when the water level of the lagoon is higher than that of the landfill. Analyses of leachate from various landfills sites shows that the water and dissolved contents is more benign than would be expected from the types of material interred in the tip would lead one to expect. The most common component is ammonia-nitrogen. Phosphorus and metal concentrations are very low suggesting that they remain bound to soil particles within the landfill.

The leachate problem of Curl Curl Lagoon may be tackled in the following way :

- The surfaces of the landfill sites (beneath the sports fields) must be sealed by proper placement of impervious clay. The sports fields may then be rebuilt.

- An impervious bund must then be built just back from the waters edge of the lagoon to prevent water movement from the landfill to the lagoon and from the lagoon to the landfill.
- Once the landfill has been sealed from stormwater and from the lagoon, wells can be drilled into the landfill and fitted with pumps and float switches. Leachate can be pumped to the nearest sewer with the capacity to receive it. Eventually the landfill will be dewatered and aerobic conditions may then prevail which would allow the garbage to decompose. At the very least, dry anaerobic processes will be established which will produce methane gas which has a value as an energy source.

Improving Stormwater Quality

Once the leachate problem has been solved, attention can be focused on improving the quality of stormwater entering Curl Curl Lagoon. Stormwater enters the lagoon via Greendale Creek or from a number of drains running directly to the lagoon. Water emerging from the upper catchment (sampled at CC1) does not change its composition much in wet or dry weather and contains acceptable levels of TN and TP. The section of Greendale Creek between the brickworks and Harbord Road GPT (sampled at CC2 and CC3) flows constantly in both wet and dry weather (the moderate flows even in drought conditions appeared odd to begin with). Water entering the lagoon from Greendale Creek contains high concentrations of oxidized nitrogen and before the GPT was built, quite low levels of total phosphorus. Since the GPT was built, TP levels appear to have increased markedly. This is, however, an artifact generated by the poor management of the GPT (Laxton, 2000). The source of most of the dry weather flow in Greendale Creek is a substantial leak in the municipal water supply. I have kept the information of this leak to myself because the water provides a significant environmental flow to Curl Curl Lagoon to dilute the leachate in the estuarine section. If Sydney's water storage fell to a critical level I would report this leak and the many others I have discovered in the course of my work. If the leachate problem was solved, repairing of this leak would make a significant reduction to total nitrogen levels in Curl Curl Lagoon. It would also help if the GPT was managed intelligently.

The flows from smaller drains entering Curl Curl Lagoon could be treated using small wetlands like the one at Surf Road. These small wetlands do not do much for dissolved nutrients but are good at removing particulate nutrients if they are managed properly.

Lagoon Ecology

Even if there is a gradual improvement in water quality of Curl Curl Lagoon, the rapid opening and closing regimen will still occur. The design of a water quality and ecological monitoring programme to document these changes will have to take these factors into account.

The first step would be to characterise two or more of the ecological cycles as they presently exist (to form a baseline of present conditions). All major elements of the ecosystem would be sampled from the moment the lagoon drained to the moment of the next draining. Drainings at different times of the year would be studied to obtain

information on temporal variation in community structure and behaviour. Studies of each ecological cycle would include the following :

- Hourly changes in water depth, temperature, salinity, pH, dissolved oxygen and turbidity of surface and bottom water.
- Every second day samples of surface and bottom water would be analysed for ammonia-N, TKN, organic-N, nitrite-N, nitrate-N, TN, ortho-P, organic-P, total-P, total suspended solids, inorganic suspended solids, volatile suspended solids, chlorophyll-a (a water sample would be preserved in Lugol's Iodine to permit taxonomic evaluation) and zooplankton (to be sampled at night).
- Each week replicate samples of benthos would be collected from the lagoon bed.
- A seine net would be stretched across the lagoon entrance channel to sample fish and other pelagic organisms leaving the lagoon during the next breakout.

With the implementation of each step of the management plan, a small number of ecological cycles could be investigated and changes noted.


Between times, the existing lagoon water quality sampling programme should be continued to produce a data set that can be used to follow longer term changes and to detect unforeseen events.

Reference

Laxton, J.H. & E.S. 2000. Warringah and Manly Councils. *Water Quality of Warringah lagoons in 1994-99*. January 2000.

I hope this review and information is of use to you. If you have any questions please ring me on (02) 9449 7846.

Yours faithfully

A handwritten signature in cursive script that reads "John H Laxton".

John H. Laxton.