COOKS RIVER
Stormwater Management Plan

Cooks River Catchment Association of Councils

Ashfield Council, Auburn Council, Bankstown Council, Botany Bay City Council, Burwood Council, Canterbury City Council, Hurstville Council, Kogarah Council, Marrickville Council, Randwick Council, Rockdale Council, South Sydney City Council, Strathfield Council

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Key Stakeholders:

Australian Conservation Foundation	*Landcom*
Building Lands Group	*Masterbuilders Association*
Centennial & Moore Park Trust	*National Rail Corporation*
City West	*Rail Services Australia*
Cooks River Coalition	*Rail Access Corporation*
Cooks River Valley Association	*Nature Conservation Council*
Department of Land & Water Conservation	*NSW Fisheries*
Department of Urban Affairs & Planning	*South Sydney Development Corporation*
Environment Protection Authority	*Sydney Airport*
Ethnic Communities Council	*Total Environment Centre*
Freight Corp	*Waterways Authority of NSW*
Friends of the Earth	*Local Aboriginal Land Council*
Greening Australia	*Housing Industry Association*

Many community stakeholders also provided valuable input through questionnaires and workshops. A list of the residents and businesses who contributed to the development of the Plan is provided in Appendix C.

This document has also benefited from comments provided by Eric Hatfield (EPA), who gained extensive knowledge of the Cooks River catchment in his former role as a catchment manager.

The photographs on the cover of this document were taken by Kathy King (Cooks River Valley Association) and illustrate the litter boom at Fifth Avenue, Campsie, and an estuarine section of the Cooks River.

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Executive Summary

The 13 Local Councils of the Cooks River catchment, working together with State Authorities and the community, have prepared a Stormwater Management Plan for the Cooks River. The Plan aims to improve water quality and the health of the Cooks River by identifying practical and long term solutions to stormwater problems.

The preparation of the Plan is a response to a Direction issued by the Environment Protection Authority under Section 12 of the *Protection of the Environment Administration Act, 1991.* Through the Stormwater Trust, the State Government has provided funding for the preparation of Stormwater Management Plans for all catchments within NSW. PPK Environment and Infrastructure Pty Ltd, in association with Webb McKeown and Associates Pty Ltd were appointed by the Cooks River Association of Councils to prepare the Stormwater Management Plan.

Stormwater Pollution Problems

The Cooks River is one of the most polluted river systems in Sydney. Present levels of pollutants, including nutrients, sediments, toxicants and faecal coliforms, make the Cooks River unsafe for swimming, unsuitable for many aquatic species, and a health risk for commercial fishing. Stormwater pollution, together with sewage overflows, is considered to be the biggest contributor to poor water quality in the Cooks River.

The visual and recreational amenity of the river is also compromised as a result of concrete lining of the river banks, floating litter, and impediments to public access. The Cooks River Catchment has a history of intensive landuse, and extensive channel modifications which have dramatically changed the natural appearance and processes of the river system.

The Approach

The approach to developing a Stormwater Management Plan closely follows the methodology and principles set out in the Environment Protection Authority's *Draft Council Handbook for Managing Urban Stormwater* (1997). The Plan has the following key components:

- clear definition of catchment values and objectives for stormwater management;
- identification of issues which prevent the objectives from being satisfied;
- evaluation of options to address identified stormwater management issues;
- a detailed Action Plan which identifies and prioritises cost-effective actions specific to the management of stormwater within the Cooks River;
- an Implementation Strategy which defines the management framework, details costs and outlines a timeframe for implementation; and
- an Evaluation, Monitoring and Reporting Program which provides performance indicators for the actions and identifies appropriate monitoring to measure and report on the success of the Stormwater Management Plan.

The restoration of the Cooks River requires a combination of strategies to address the range of factors contributing to poor water quality and consequent poor river health. The Stormwater Management Plan aims to address issues specifically relating to stormwater, whilst working within the existing Catchment Management Framework.

Catchment Values and Objectives

The catchment values of the Cooks River, identified through the consultation process, include ecological, recreational, amenity, health and economic values. Catchment values lead to objectives for stormwater management as detailed in the following table. Stormwater management objectives include both long term objectives aimed at achieving the community's vision for the Cooks River and short term quantifiable objectives which can bring about immediate improvements.

Catchment Values	Long-Term Stormwater Management Objectives	Short-Term Stormwater Management Objective
Ecological Values:		
▪ Remnants of the original vegetation and creek lines of the River ▪ The presence of native water birds, fish and aquatic flora and fauna ▪ Visually attractive riparian vegetation along the river banks (weed free) ▪ The existing wetland areas and intertidal zone which attract large numbers of waterbirds ▪ Remnant vegetation and native animals of special conservation value such as the endangered Cooks River Clay Plain Scrub Forest, and birds protected by international treaties ▪ Natural creek banks as opposed to concrete walls and sheet piling	1. Protect and enhance remnant foreshore vegetation and natural waterways.	Protect all remnant vegetation of ecological significance and natural waterways from the impacts of stormwater from future developments.
	2. Protect and enhance existing wetlands and intertidal zones from the impacts of stormwater.	Protect all remnant wetlands of ecological significance, remaining floodplain and intertidal areas from the impacts of stormwater from future developments.
	3. Recreate aquatic habitats suitable for native waterbirds and fish .	Replace sections of concrete channel with more natural waterway in five areas.
	4. Recreate natural riparian and bushland habitats to act as a buffer zone for stormwater.	Restore the natural riparian zone in three sections along existing natural channels.
	5. Achieve water quality which meets the requirements for protection of aquatic ecosystems in all tidal areas and natural channels.	Achieve water quality which meets the guidelines for protection of aquatic ecosystems in tidal areas and natural channels at least fifty percent of the time.

Catchment Values	Long-Term Stormwater Management Objectives	Short-Term Stormwater Management Objective
Social Values:		
▪ Boating and secondary contact recreation throughout the catchment ▪ Swimming in the tidal mouth of the River ▪ Fishing and the safe consumption of fish caught in the River ▪ Recreational areas with water features which are visually pleasing and safe ▪ Walking and bike tracks following the River with no visual pollution (that is, no murky water or floating litter) ▪ Facilities and use of waterways with environmental education and awareness themes.	6. Achieve water quality which meets the requirements for primary contact recreation in tidal sections of the river and the requirements for secondary contact recreation in all waterways.	Achieve water quality which meets the requirements for secondary contact recreation in all waterways more than 75% of the time.*
	7. Maximise the visual amenity of waterways by achieving clear rather than murky water.	Achieve reduction in suspended solid levels in all waterways and control of bank erosion in a sustainable manner.
	8. Maximise the visual amenity of waterways by achieving no floating litter	Ensure that no significant litter is visible in waterways during dry weather and the total volume of litter collected in the five key SWC trash racks/GPTs is reduced by 20%.
	9. Achieve water quality which meets requirements for consumption of fish	Achieve water quality which meets requirements for consumption of fish in the lower Cooks River more than 50% of the time.
	10. Ensure that the stormwater system is of minimal risk to public health and maximise opportunities for environmental education.	Ensure that public safety and education is considered in the design of all structural stormwater management works.
Economic Values:		
▪ Improved property values due to improved waterway values. ▪ Stormwater suitable for reuse	11. Promote reuse of stormwater for irrigation.	Maximise opportunities for stormwater reuse on Golf Courses and a new developments considered.

* In making this commitment for stormwater management, Councils note that the presence of faecal coliforms in the waterways is largely due to sewerage system overflows rather than to stormwater pollution.

Stormwater Management Issues

Stormwater management issues comprise the factors that currently prevent the above stormwater management objectives from being realised. Major stormwater management issues identified for the Cooks River include:

- large volumes of litter reducing visual amenity;
- elevated levels of nutrients and bacteria;

- high concentrations of toxicants;
- lack of co-ordination of management efforts;
- elevated suspended solid levels; and
- loss of natural habitats and poor river health.

Stormwater Management Options

A large number of options to address the stormwater management issues within the Cooks River system have been investigated and assessed on a cost-benefit basis. Generally, these options follow a hierarchy:

1. Retain and restore natural processes – options which are aimed at maintaining the natural drainage and treatment processes such as wetlands, riparian zones, intertidal zones and natural creek lines.
2. Source control – options which involve managing pollution of stormwater at the source and/or minimise the generation of excess stormwater run-off. Source controls include education programs and management procedures to change polluting behaviour, as well as the installation of infiltration devices to intercept pollutants before they enter the stormwater system.
3. "End of Pipe" Solutions – options that trap or treat pollutants which have made their way into the drainage system. The end of pipe solutions are often structural and include gross pollutant traps, sediment detention basins, and litter booms.

The development of stormwater management options for the Cooks River closely follows this hierarchy, by focusing on actions which will restore the natural functions of the waterways, and control pollutants before they enter the river system. However, in a catchment as modified and polluted as the Cooks River, a range of options from each level of the hierarchy will be required in order to achieve both the short and long term stormwater management objectives.

Action Plan

Based on the evaluation of options, an Action Plan has been developed which identifies priority stormwater management actions, and assigns responsibilities for implementation.

Practical strategies have been identified to address the causes of each issue and group stormwater management actions. Each management strategy has specified performance indicators against which the success of the stormwater management actions can be assessed. A Monitoring and Evaluation Program has been developed to enable assessment of overall progress towards meeting the objectives of the Stormwater Management Plan.

The Action Plan (*Table 8.1* in this report) is not intended to be static and will be subject to continual improvement as options are investigated further and monitoring and evaluation of the actions is undertaken.

Implementation Strategy

The costs and responsibilities for the implementation of stormwater management actions have been identified in the Plan. The thirteen local Councils of the Cooks River are committed to implementing the identified priority actions. Actions have also been identified for key Government Agencies such as Sydney Water and the Roads and Traffic Authority.

Many of the actions identified in the Stormwater Management Plan will be most effective when implemented on a catchment-wide basis. The allocation of responsibilities to address catchment wide stormwater issues has been problematic in the past. It is therefore recommended that a "co-ordinating body" be established with appropriate powers and resources to co-ordinate catchment actions. In the short term the Association of Councils, who have developed this Plan, will continue to implement the catchment wide actions within the Plan. In the long term, the formation of a Catchment Management Trust under the *Water Supply Authorities Act, 1987,* is recommended as the most appropriate co-ordinating body.

The Councils of the Cooks River are committed to implementing the priority actions identified within this Plan. However, significant funds will be required to meet the objectives of the Plan and reverse over 200 years of River alteration and degradation. As Councils have limited available funds and many other responsibilities the timeframes identified for implementation are considered tentative, and will be reviewed on an annual basis. The actions identified in the Stormwater Management Plan will be incorporated into each Council's management planning process.

Funding Mechanisms

Additional funding sources have been identified and include the Commonwealth, State and local Governments, the business sector and individual beneficiaries. Generally costs have been allocated between public and private stakeholders to create a cost-sharing framework. Opportunities for local government to generate funds for catchment management actions include:

- seeking funds from government natural resource management programs such as the National Heritage Trust, the Estuary Management Program, and the Stormwater Trust;
- applying Section 94 contributions and special levies obtained from the beneficiaries;
- raising a catchment levy by use of levy powers under the Water Supplies Authority Act, 1987; and
- collecting contributions from point source polluters to ensure that they pay the full cost of remediating their actions.

Funding has recently been awarded to the Cooks River Association of Councils through the Stormwater Trust to implement $1.3 million worth of priority actions identified in this Stormwater Management Plan. Sydney Water Corporation has also committed $4 million towards the improvement of water quality within Alexandra Canal, one of the most polluted tributaries of the Cooks River.

1. Introduction

In urban catchments, stormwater is a major contributor to pollution of our waterways, ultimately affecting the biological, physio-chemical, social and economic values of our river systems. As a State Governmental initiative to solving the stormwater problem, the Environment Protection Authority has issued a Direction under Section 12 of the *Protection of the Environment Administration Act (1991)* requiring all local Councils to prepare catchment-based stormwater management plans to mitigate against this form of pollution. Legal directions also require Sydney Water Corporation, and the Roads and Traffic Authority to participate in the preparation of this stormwater management plan.

PPK Environment & Infrastructure Pty Ltd in conjunction with Webb, McKeown & Associates Pty Ltd were engaged by the Cooks River Catchment Association of Councils to investigate stormwater issues and to prepare a Stormwater Management Plan for the Cooks River catchment.

The Stormwater Management Plan aims to improve water quality and health of the Cooks River by identifying practical and long term solutions to stormwater pollution problems. Stormwater quality is affected by all activities and management practices that occur within the catchment and therefore is the responsibility of all Authorities, businesses, industries, residents and land users within the catchment. The Councils within the Cooks River Catchment have formed an association and are working together with the community and stakeholders in the preparation and implementation of this Stormwater Management Plan. The Association of Councils is made up of representatives from the thirteen Councils responsible for management of the Cooks River catchment, as listed in *Table 1.1*.

Table 1.1: Council Areas within the Cooks River Catchment

Council	Percentage of Cooks River Catchment / Local Government Area
Canterbury	23.7
Rockdale	19.9
Marrickville	11.9
South Sydney	10.0
Hurstville	9.1
Bankstown	8.9
Strathfield	6.7
Botany Bay	5.3
Burwood	1.9
Auburn	0.8
Randwick	0.7
Kogarah	0.6
Ashfield	0.5

Canterbury City Council, 1997).

1.1 Approach

The overall objective of the Stormwater Management Plan is the development of a framework which will provide for the ecologically sustainable & cost effective management of stormwater. The approach used to develop this Stormwater Management Plan follows closely the methodology and principles set out in the Environment Protection Authority's *Draft Council Handbook for Managing Urban Stormwater* (1997). As required by the Section 12 Direction, the Plan incorporates the following key components:

- a description of the Cooks River catchment;
- the definition of stormwater management objectives for the catchment;
- identification of stormwater management problems and issues;
- the evaluation and ranking of potential stormwater management options;
- an implementation strategy which defines the management framework, detailed costs of implementing the actions, and identifies a timeframe for implementation;
- a monitoring program to assess the effectiveness of the plan; and
- an evaluation and reporting program.

The Stormwater Management Plan is based on the findings of numerous existing studies of the Cooks River, and on the outcomes of consultation with stormwater managers, businesses, and residents within the Cooks River catchment. While the primary focus of this plan is to address the stormwater pollution problems of the Cooks River, additional issues such as water quantity and ecosystem restoration are also considered to ensure an integrated approach to the management of the Cooks River.

1.2 Guiding Principles and Best Practice

Management of stormwater within the Cooks River catchment is based on the principles of total catchment management and ecologically sustainable development.

Ecologically sustainable development requires the effective integration of economic and environmental considerations in decision making processes. Ecologically sustainable development can be achieved through implementation of the precautionary principle, inter-generational equity, the conservation of biological diversity and ecological integrity, and improved valuation and pricing of environmental resources. In giving effect to ecologically sustainable development the following issues must be considered:

- decision making processes should effectively integrate both long and short term economic, environmental, social and equity considerations;

- where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
- cost effective policy instruments should be adopted such as improved valuation, pricing and incentive mechanisms; and
- decisions and actions should provide for broad community involvement on issues which affect them.

Total catchment management is the co-ordination of local and state government, business and community efforts on a catchment basis so as to maintain clean water and a diversity of vegetation and wildlife. The objectives of total catchment management are to ensure that natural resources are managed by:

- co-ordinating policies, programs and activities at a catchment level;
- achieving active community participation in natural resources management;
- identifying and rectifying natural resource degradation;
- promoting the sustainable use of natural resources; and
- providing high quality water and natural vegetation cover.

In developing the Stormwater Management Plan for the Cooks River, the principles of total catchment management and ecologically sustainable development have been adopted, and best practice management encouraged. Best practice in regard to stormwater management is the subject of many existing guideline documents including:

- Managing Urban Stormwater - Soils and Construction (NSW Department of Housing, 1998);
- Managing Urban Stormwater: Treatment Techniques (EPA, 1998);
- Managing Urban Stormwater: Source Control, Draft (EPA, 1998);
- Construction Techniques for Sediment Pollution Control (Environment Protection Authority, 1991);
- Environmental Guidelines for Major Construction Sites. Best Practice Environmental Management Series (Environment Protection Authority, 1996);
- Estuary Management Policy (NSW Department of Land and Water Conservation,);
- Aquatic Habitat Management and Fish Conservation (NSW Fisheries, 1998); and
- Better Drainage (Department of Urban Affairs and Planning, 1993).

It should be noted that best practice is site specific and must balance environmental, social, and economic considerations. The actions and strategies identified in this Stormwater Management Plan reflect the need for such a balance.

1.3 Catchment Management Framework

The Cooks River, labelled the most polluted river system in Sydney, has been significantly altered and degraded over the last 200 years (CSIRO, 1992). Stormwater pollution, which is addressed by this Plan, is only one of a complex combination of past and present pollution sources contributing to the degraded water quality and poor health of the River. Other sources of water pollution in the Cooks River, which are addressed by other plans and strategies, include:

- seeps and overflow from the sewer;
- licensed and unlicensed discharges from industry;
- leachate inputs from contaminated land;
- release of chemicals from contaminated sediments; and
- inputs from contaminated groundwater.

In addition, a number of plans and strategies exist which aim to re-establish the natural processes and ecosystems of the Cooks River. The Cooks River Catchment Management Committee, local Councils, community and State Government agencies have defined the vision for the future of the Cooks River, as a healthy natural waterway within a sustainable urban landscape that can be enjoyed for its recreational, visual and ecological values.

This stormwater management plan, along with plans developed to address other problems of the Cooks River, form part of a catchment management framework established to guide the rehabilitation of the Cooks River. Figure 1 illustrates this catchment management framework which incorporates:

- an overall strategy and objectives to achieve the vision for the Cooks River;
- remediation programs to address the legacy of past impacts on the Cooks River;
- management plans to address current impacts on the Cooks River;
- planning policies to ensure future developments and redevelopments within the catchment are ecologically sustainable; and
- monitoring, evaluation and reporting program to assess performance and ensure continual improvement in catchment management.

Details of the existing components of this catchment management framework are provided below.

Cooks River Catchment Management Strategy:	The Cooks River Catchment Management Strategy was prepared by the Cooks River Catchment Management Committee (1993) to define the problems of the River and identify strategies for the rehabilitation and improved management of the catchment. This Catchment Management Strategy is being updated for release in 1999.

Water Quality Objectives:	Water quality objectives for the Cooks River have been developed in consultation with stakeholders as part of the NSW Government's Water Reforms Process. The interim environmental objectives (water quality) published by the Environment Protection Authority, 1997, are detailed in *Section 5.2* of this report.
Remediation Plans:	A number of remediation projects are currently being undertaken throughout the catchment to control leachate from past Council landfills and sites contaminated through past industrial landuse. Plans to address contaminated sediments within Alexandra Canal are being prepared following a feasibility study undertaken by Sydney Water.
Sewage Overflow Licensing Project:	Sydney Water has recently undertaken an Environmental Impact Assessment of sewage discharges from the sewerage reticulation system, including sewer overflows, exfiltration, infiltration, odours and sewage treatment plant bypasses. Based on the results of this assessment Priority Programs are being prepared to upgrade the sewerage system and prevent major sewage discharges into the Cooks River in the future.
Alexandra Canal Water Environment Plan:	As part of the City South Project, a plan was prepared to address water quality in one of the major hotspots in the Cooks River. The Plan identifies actions for rehabilitation of the Alexandra Canal in a framework similar to that of the Stormwater Management Plan.
Council Management Plans:	Each of the thirteen Councils within the Cooks River Catchment have a Management Plan which guides works and management activities for the future years. Many of these Plans include catchment management actions which aim to improve the Cooks River.
Groundwater Management Plan:	The Department of Land and Water Conservation is preparing a Groundwater Management Plan for the Botany Sands Aquifer.
Council Planning Controls:	Each Council area is also subject to a number of planning controls including Local Environment Plans, development control plans, and catchment related planning policies. These controls place requirements on future developments and are the tools by which future adverse impacts on the Cooks River can be avoided.

Cooks River Foreshore Strategic Plan:	A Strategic Plan for the foreshores of the Cooks River was developed in 1997 (Cloustan, 1997). The Plan focuses on strategies to ensure a co-ordinated approach to future development and management of the river foreshore areas. Recreational opportunities along the foreshores of the Cooks River are also identified.
State of the Environment Reports:	State of the Environment Reports and State of the Catchment Reports are prepared by Local Councils on an annual basis and report on performance against strategies based on the results of monitoring programs. These monitoring and reporting programs allow for measurement of the success of management plans in achieving catchment strategies and objectives.

The restoration of the Cooks River requires these existing management plans, the development of additional plans such as the Stormwater Management Plan, and significant funds and resources to implement the actions within the plans.

The Stormwater Management Plan will address issues specifically relating to stormwater within this existing Catchment Management Framework.

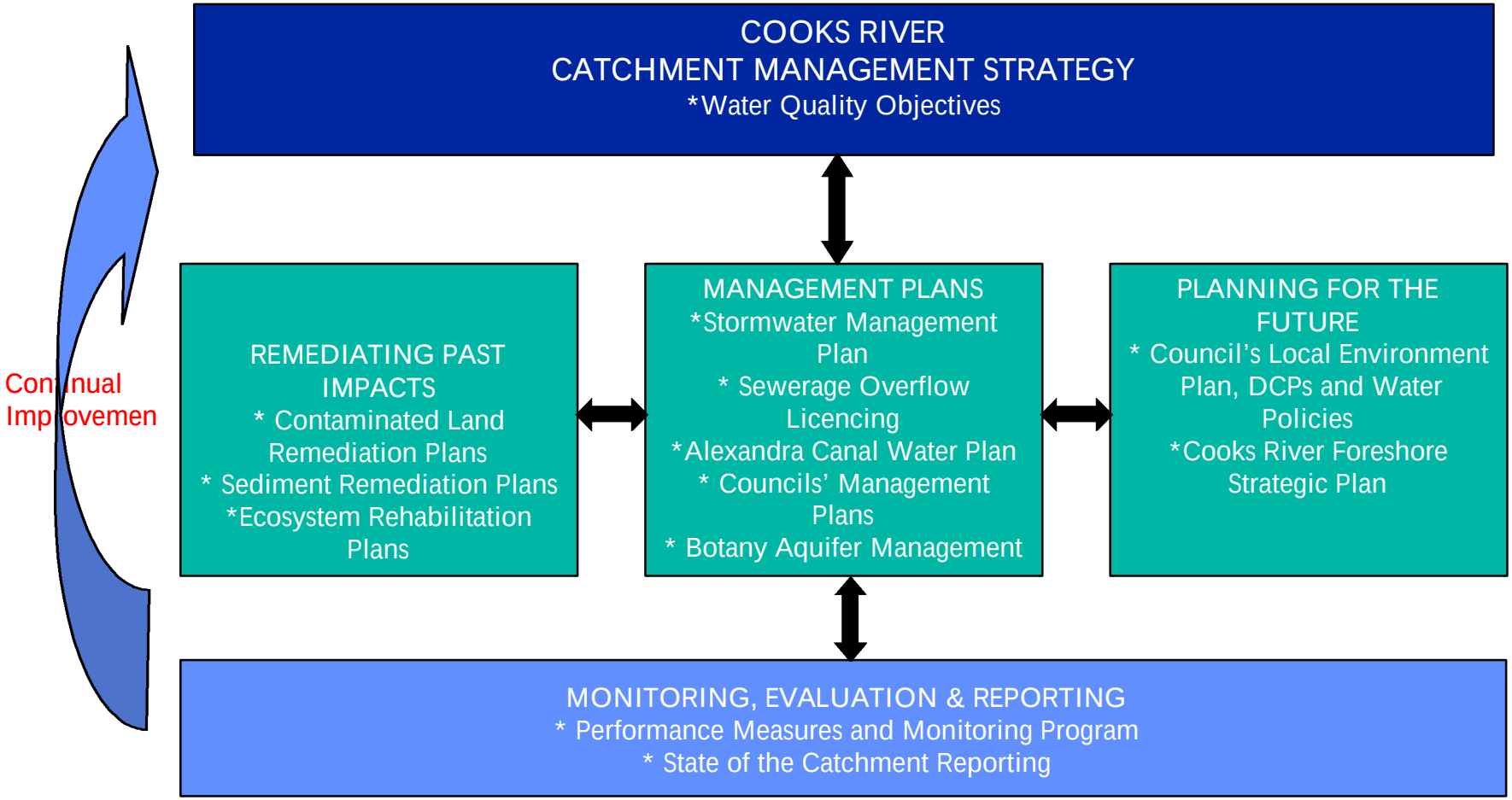


Figure 1: Cooks River Catchment Management Framework

2. Catchment Description

2.1 Historical Context

Prior to European settlement, it has been estimated that about 1,500 aborigines inhabited the Port Jackson/Botany Bay area. The Aboriginal population fished, gathered shellfish, hunted and undertook subsistence cropping along the Cooks River (Muir, undated). The Darug people, who were the traditional inhabitants of the Sydney region claim to be the traditional owners of most of the Sydney Basin, including the Cooks River catchment (Hyder Consulting, 1997)

Captain Cook was the first recorded non-native to enter the Cooks River. In 1770, Captain Cook reported on "a fine stream of fresh water" entering the Bay and suggested that the lands within the river's catchment offered fertile lands that were appropriate for agriculture. However, in 1788, colonists looking to open up the area as a site for potential agriculture found "low and boggy" country that was not seen as being conducive to traditional European agricultural practices (Cooks River Catchment Management Committee, 1993a).

However, colonisation went ahead, and initially the catchment was used for farming, timber gathering, fishing and recreational pursuits. Major industries during the early nineteenth century included fishing and lime burning for making mortar (Muir, undated). During 1839, a dam was constructed at Tempe by convict labourers to provide a constant supply of fresh water for Sydney. However, the water above the dam remained saline and was found to be unsuitable as a water supply. The prevention of tidal flushing and the sedimentation upstream of the dam had deleterious effects on the aquatic ecology so the dam was removed (Muir, undated).

A second dam was built in Canterbury during the 1840s to service the Australian Sugar Company's refinery. Following establishment of the refinery, infrastructure and service amenities were built to cater for the industry workers. The sugar refinery closed in 1855. However, wool washes, tanneries and rendering works were established along Alexandra Canal and Cup and Saucer Creek and provided continuous sources of pollution (Muir, undated).

By the middle of the nineteenth century, several thousand people had settled in the catchment and there was a thriving industrial village. The wastes generated from this large settlement included overflowing septic tanks, household wastes and effluent derived from industries including slaughter houses, soap factories, sewage farms, tanning factories and chemical manufacturing (Cooks River Catchment Management Committee 1993a).

In 1886, Alexandra Canal was dredged and channelised to enable boat transportation. It was during this period that sewerage and stormwater infrastructure was constructed in the Sydney region. This infrastructure brought some improvement to the health of the catchment (Cooks River Catchment Management Committee 1993a).

During the 1920s, erosion of the banks was identified as a major source of sediment contributing to siltation of the river and tributaries. The government authorities opted to protect the banks by installing training walls and concreting much of the waterways, particularly in the upper reaches of the catchment (Cooks River Catchment Management Committee 1993a). These works resulted in many undesirable effects including reduction in dry weather flow velocities and a corresponding reduction in the catchments' flushing ability. Conversely, during wet weather flows, the greatly increased flow velocities caused major flood damage (Cooks River Catchment Management Committee 1993a).

In 1946, the *Cooks River Improvement Act* was gazetted with its primary aim being to control flows and prevent degradation of the banks. The upstream banks were sealed with concrete and, during the 1950s, the lower reaches of the river and Alexandra Canal were diverted to allow for the draining of land for the enlargement of Sydney Airport (Cooks River Catchment Management Committee 1993a).

Over the 200 years of European settlement, the Cooks River has been altered and degraded by a wide variety of activities including:

- vegetation clearing;
- draining of wetlands;
- diversion of natural drainage;
- concrete lining of channels and banks;
- dredging;
- industrial activities;
- roads and transport routes;
- development of residential areas;
- dumping of wastes;
- landfilling; and
- sewage contamination (Cooks River Catchment Management Committee 1993a).

2.2 Location

The Cooks River catchment is located in the southern suburbs of Sydney and covers an area of 10,000 hectares (Cooks River Catchment Management Committee 1993b) (*Figure 2*). The Cooks River originates near Graf Park in Bankstown and flows 23 kilometres east to discharge into Botany Bay just south of Sydney Airport (Webb 1994).

The major tributaries of the Cooks River are Wolli and Bardwell Creeks, Muddy Creek (also called Kyeemagh Canal), Alexandra Canal and Sheas Creek, Cup and Saucer Creek, Cox's Creek and Freshwater Creek. These tributaries and their sub-catchments are identified on *Figure 2* and detailed below.

Figure 2

Cooks River Catchment Location

2.2.1 Tributaries

Wolli Creek and Bardwell Creek, are located within the local government areas of Hurstville, Rockdale, and Canterbury. The Wolli Creek Sub-catchment drains stormwater from Narwee, Penshurst, Hurstville, Beverly Hills, Kingsgrove, Bexley, Bardwell Park and Turrella. The combined catchment area for Wolli Creek and Bardwell Creek is 21.9 square kilometres (Cooks River Catchment Management Committee 1997).

Muddy Creek flows through Rockdale, Hurstville and Kogarah Council areas in a north-easterly direction and drains to a tidally flushed estuary. The total catchment area is 5.6 square kilometres (Cooks River Catchment Management Committee 1997).

Alexandra Canal flows in a south-westerly direction and drains part of Botany Bay, Marrickville, and South Sydney Council areas, and the Sydney Airport (Water Board, undated). Sheas Creek is the engineered stormwater drain which flows into Alexandra Canal. Sheas Creek drains a catchment containing portions of the southern Sydney suburbs of Surry Hills, Alexandria, Waterloo, Zetland, Beaconsfield and Redfern (South Sydney Council 1997; Webb 1991). Alexandra Canal and Sheas Creek have a combined catchment area of 16.6 square kilometres. The catchment constitutes approximately 39 percent of South Sydney City Council. It also extends into a small part of Kensington in the Randwick City Council Local Government Area (South Sydney Council 1997).

Cup and Saucer Creek is located within the Canterbury Local Government Area and has a catchment area of 5.5 square kilometres stretching from the Cooks River at Canterbury to the Canary Road reservoir near Roselands (Water Board 1992). The Creek is little-more than an open drain that extends from Lakemba through South Belmore, Earlwood and Clempton Park to the Cooks River at Canterbury.

Cox's Creek has a catchment area of 8.8 square kilometres in the Strathfield Local Government Area. The creeks flows in a north-easterly direction starting at the Enfield Marshalling Yards and meeting the Cooks River at Strathfield South.

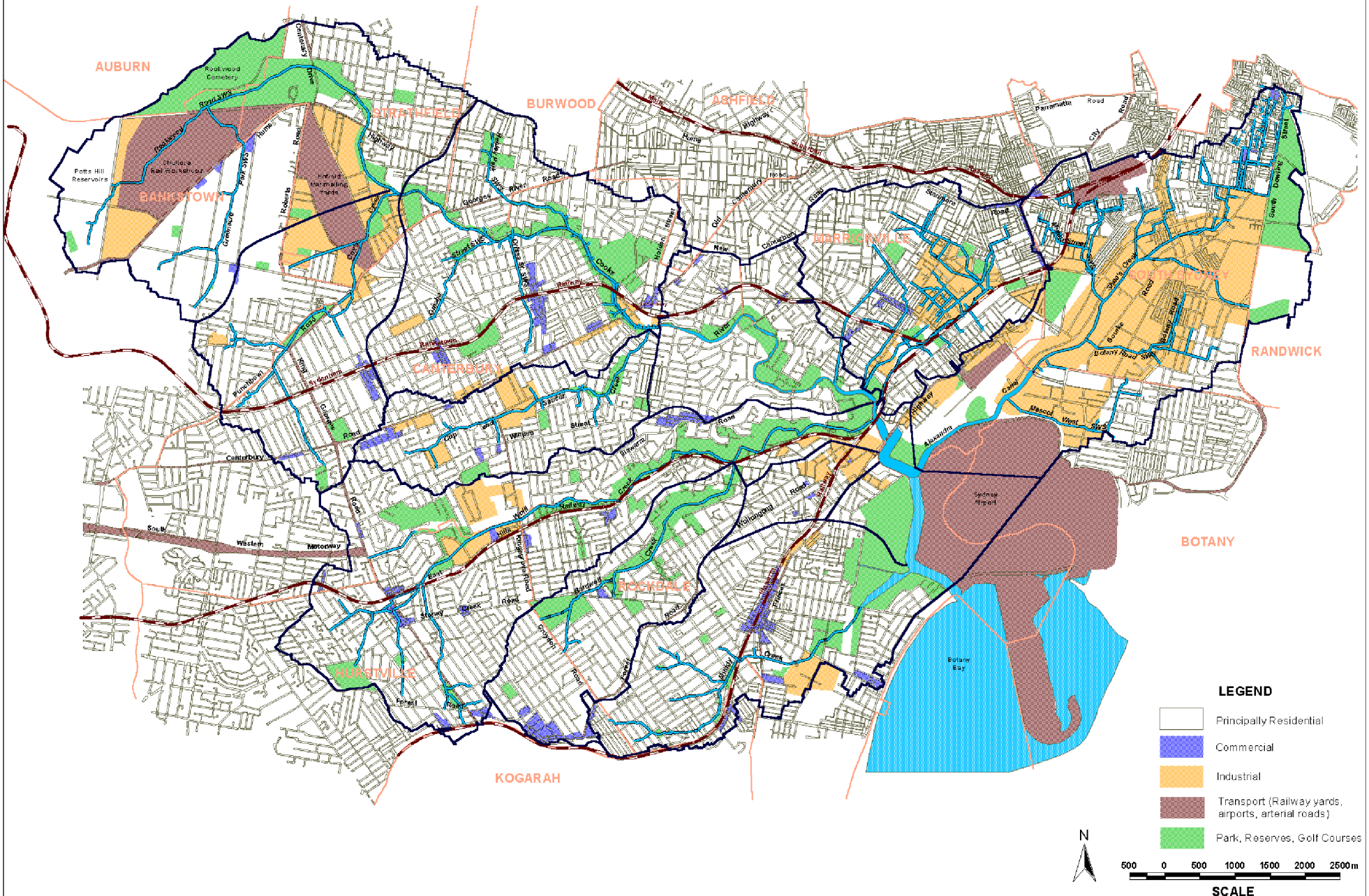
Freshwater Creek is also located at the head waters of the catchment in the Strathfield Local Government Area. It flows in a south-easterly direction from Strathfield Golf Course and becomes the Cooks River in Strathfield South. The total catchment area is 13.1 square kilometres

2.3 Land Use

The Cooks River catchment area is highly developed, providing home to almost 400,000 people with 130,000 dwellings and over 100,000 commercial and industrial premises (CRCMC 1993a). The catchment is occupied by a variety of uses, ranging from industrial to open space. The existing land zonings are illustrated in *Figure 3* and discussed in detail below.

Figure 3

Cooks River Catchment
Landuse



The major land uses within each of the sub-catchments of the Cooks River were surveyed during *The Cooks River Catchment Pollution Source Inventory* (Cooks River Catchment Management Committee, 1997) as identified in *Table 2.1*.

2.3.1 Residential Land Use

Residential land use is the predominant zoning within the catchment with the highest portion of residential developments being detached low density dwellings. Within the past decade there has been increased intensity of development with medium to high density residential developments occurring, particularly in Canterbury, South Sydney and Marrickville local government areas (CRCMC 1993b).

2.3.2 Industrial Land Use

The major portion of industrially zoned land is concentrated in the Port Botany area, along Alexandra Canal, within Tempe, and the southern portion of Strathfield local government area (*Figure 3*). Industrial developments also occur along both East Hills and the South Coast railway line and Canterbury Road (CRCMC 1993b).

The major industrial activities within the catchment are:

- fabricated metal products;
- machinery and equipment;
- paper, paper products and printing;
- clothing and footwear; and
- petro-chemical and liquid fuel depots (CRCMC 1993b).

There is also a heavy concentration of freight depots in the catchment, concentrated adjacent to Port Botany, Enfield, Tempe and along Alexandra Canal (CRCMC 1993b).

Commercial and industrial premises located within each sub-catchment of the Cooks River are quantified in *Table 2.2*.

Table 2.1: Land Uses within each of the Sub Catchments of the Cooks River

Land Use (km^2)	Freshwater Creek	Cox's Creek	Cup & Saucer Creek	Marrickville/ Sydenham	Wolli Creek	Bardwell Creek	Alexandra Canal	Muddy Creek	Cooks River	Total
Significant open space	1.30	0.37	0.23	0.42	1.51	1.03	1.57	0.75	3.28	10.5
Industrial area	1.25	0.98	0.58	2.13	1.47	0.08	7.34	0.48	0.51	14.8
Commercial area	0.42	0.15	0.04	0.27	0.24	0.23	0.36	0.31	0.66	2.7
Significant special use	4.01	0.20	0.00	0.43	0.61	0.01	2.61	0.39	0.70	9.0
Residential	6.11	7.06	4.66	4.02	11.68	5.00	4.72	7.04	16.38	66.7
TOTAL (km^2)	13.10 km^2	8.77 km^2	5.51 km^2	7.28 km^2	15.52 km^2	6.36 km^2	16.60 km^2	8.97 km^2	21.53 km^2	103.6 km^2
Approximate Area (km^2) of:										
Roads	1.79	2.01	1.29	1.52	3.31	1.33	2.75	1.95	4.40	20.4
Roofs	2.82	2.91	1.83	2.89	4.71	1.70	6.76	2.65	5.70	32.0

Source: The Cooks River Catchment Pollution Source Inventory (Cooks River Catchment Management Committee, 1997).

Table 2.2: Numbers of Various Types of Commercial/Industrial Premises within each Sub-catchment

Land Use	Freshwater Creek	Cox's Creek	Cup & Saucer Creek	Marrickville /Sydenham	Wolli Creek	Bardwell Creek	Alexandra Canal	Muddy Creek	Cooks River	Total
Boating	0	0	0	0	2	0	2	0	0	4
Building	5	3	1	14	8	0	54	1	3	89
Chemicals	8	2	2	18	14	1	56	1	8	110
Commercial	605	454	166	1,171	1,248	1,526	3,016	908	1,894	10,988
Food Outlets	77	70	8	204	190	185	398	177	342	1,651
Food Processing	8	7	1	48	7	0	53	1	7	132
Fuel	18	15	10	11	11	19	62	13	46	205
Laundries	17	10	2	61	26	27	81	23	42	289
Medical	5	0	2	16	11	10	2	13	12	71
Metals	32	11	10	51	41	3	125	3	19	295
Misc manufacturing	64	23	19	314	104	4	658	18	65	1,269
Motor vehicle repairs	105	8	8	47	39	39	130	17	56	4,49
Motor vehicle, other	86	19	43	50	62	86	216	67	117	7,46
Nurseries	0	0	0	0	0	0	0	1	0	1
Printers	16	12	8	105	52	23	228	30	51	5,25
Transport	35	10	1	16	14	0	166	0	7	2,49
Waste	0	0	0	0	1	0	14	1	0	16
Animals	0	0	4	4	6	2	15	6	19	56
Unclassified	104	108	41	205	225	231	527	171	355	1,967
Total	1,185	752	326	2,335	2,061	2,156	5,803	1,451	3,043	19,112

Note: These numbers are approximate only based on an industrial directory.

Source: The Cooks River Catchment Pollution Source Inventory (Cooks River Catchment Management Committee, 1997)

2.3.3 Open Space and Recreation Land Use

A thin corridor of open space fringing the Cooks River, Cox's Creek, Wolli and Freshwater Creek has survived development pressures as a result of topography and soil condition. This corridor constitutes a significant portion of the open space in the Cooks River catchment as shown in *Figure 3*. The foreshores of Muddy Creek, Alexandra Canal, Shea's Creek and Cup and Saucer Creek are more developed with less open space areas.

A portion of this significant open space corridor is owned by State Authorities including Sydney Water Corporation, Department of Public Works and Services, Department of Land and Water Conservation, Department of Urban Affairs and Planning, and the Roads and Traffic Authority. The State owned lands along the south bank of Cooks River and Wolli Creek are used by the community for passive recreation and contain remnants of natural bushland (CRCMC 1993b). A proposal is currently being prepared by National Parks and Wildlife Service for these foreshore open space areas to form a Regional Park.

2.3.4 Transport Land Use

The Cooks River catchment contains some major national and state highways, railway corridors and Sydney's airport.

Major roads in the catchment include Hume Highway, Princes Highway, and General Holmes Drive as illustrated on *Figure 3*. In addition, the M5 East Motorway is currently under construction and will pass through the floodplain of Wolli Creek. Also under construction is the Eastern Distributor which will pass through Surry Hills, Moore Park, Zetland, Rosebery, Kensington, Eastlakes and Mascot.

Four rail lines occur within the catchment area: East Hills, Bankstown, Illawarra and Botany. In addition, three major rail service areas occur: the Enfield Marshalling Yards in Strathfield, the Chullora Railway Workshops in Bankstown, and the Eveleigh Railway Workshops located in South Sydney Council area. The New Southern Railway Line is currently under construction and will tunnel under the Cooks River to Tempe.

Sydney (Kingsford-Smith) airport which covers approximately 660 hectares of reclaimed land, also lies within the catchment (*Figure 3*).

2.4 Topography

The topography of the Cooks River catchment varies from gently undulating to hilly around the urban upper reaches. The western half of the catchment is flat to gently undulating land. In contrast, the eastern section of the catchment is predominated by the high sandstone plateau around Wolli Creek.

The river starts at a height of 60 metres Australian Height Datum (AHD) at it's highest point approximately 1.5 kilometres south of Potts Hill, at a point now occupied by Graf Park, Yagoona. It flows north-east to Strathfield Golf Course, then turns and runs roughly south-east to its mouth in Botany Bay. The river stays close to the low northern boundary of the catchment, which is generally below 40 metres AHD. As a consequence, few significant tributaries exist on this side of the river. On the southern side, the dividing ridge is significantly higher being generally over 50 metres AHD (Total Environment Centre 1976). All the main tributaries are on the south side of the river, with the exception of Alexandra Canal.

The Cooks River valley floor is flat and low, allowing tidal influence to extend to Georges River Road, a point well over halfway up the river. As such, the lower reaches of the river are saline (Total Environment Centre 1976).

Topography is a natural factor dictating the velocity of run-off and the rate at which the discharge flows through the catchment and out into Botany Bay. The flatter the slopes the longer the time lag for water movement. Topography also influences depression storage areas which help to reduce peak flows during floods by storing some of the run-off. While most of the natural depression areas of the Cooks River have been infilled, Barton Park and parts of the Marrickville Basin provide significant areas of depression storage (Total Environment Centre 1976).

2.5 Climate

There are several climate stations around the periphery of the Cooks River catchment, operated by The Bureau of Meteorology (Sydney Airport, Bankstown, and Sydney Regional Office). The following is a summary of the long term average climate information extracted from these station records.

The average annual rainfall over the catchment is approximately 1100 millimetres. There are some slight variations in annual rainfall averages between the stations, typically showing that less rainfall occurs over the western parts of the catchment. On average, the highest rainfall occurs between January and June (with highest rainfall in March) and the lowest rainfall between July and December (with lowest rainfall in September).

There is very little variation in temperature across the catchment. The morning temperature ranges from an average of 10 degrees in July up to 22 degrees in the summer months (December to February).

Long term climate data for Sydney Airport are summarised in *Table 2.3*.

Table 2.3: Climate Averages

Month	Mean Monthly Rainfall (millimetres)	Highest Daily Rainfall (millimetres)	Mean 9am Temperature (°C)	Mean Monthly Evaporation (millimetres)	Mean Daily Sunshine (hours)
January	98	157	22	217	7.4
February	112	216	22	179	7.2
March	125	202	21	161	6.9
April	106	174	18	123	6.8
May	97	166	14	90	5.8
June	126	151	12	75	6.0
July	67	133	10	84	6.6
August	78	207	12	115	7.9
September	63	115	15	141	7.8
October	74	112	18	177	7.9
November	93	143	20	195	7.8
December	77	182	22	229	8.1
Annual Average	(total) 1106	216	17	(total)1744	7.2

Source: Bureau of Meteorology (Station 066037, Sydney Airport)

2.6 Geology and Soils

2.6.1 Geology

The Cooks River catchment lies close to the transitional zone between two major geological groups:

- Hawkesbury Sandstone Group - composed of highly lenticular beds of quartz rich sandstone. The group reaches its maximum depth just north of Sydney at 240 metres. The Narrabeen formation, while part of the overall Hawkesbury series does not appear as part of the surface geology (Total Environment Centre 1976); and
- Wianamatta Group - composed of a sequence of interbedded grey shales and lithic sandstones and may be divided into two sub-groups: the Liverpool Sub-group (pre-dominantly shale) and the Ashfield Shales. These shales, some 60 metres thick, are black mudstones and silty shales with frequent sidentic mudstone (clay ironstone) banks (Total Environment Centre 1976).

2.6.2 Soils

In *Soil Landscapes of the Sydney 1:100,000 Sheet* (Chapman & Murphy, 1989), nine soil landscape groups were identified within the Cooks River catchment:

1. Gymea: this highly erosive and infertile soil type lies on undulating to rolling rises and low hills (with slope gradients of around 10-25 percent) of the Hawkesbury Sandstone geological group. The soils are characteristically shallow to moderately deep (30-100 centimetres) yellow earths and earthy sands on crests and inside of benches; shallow (less than 20 centimetres) siliceous sands on leading edges of benches; localised gleyed podzolic soils and yellow podzolic soils on shale lenses; shallow to moderately deep siliceous sands and leached sands along drainage lines
2. Hawkesbury: this highly erosive soil type lies on the rugged, rolling to very steep hills (slopes of more than 25 percent) of the Hawkesbury Sandstone. The soils are characteristically shallow (less than 50 centimetres) discontinuous lithosols/ siliceous sands associated with rock outcrop; earthy sands, yellow earths and some yellow podzolic soils on inside of benches and along joints and fractures; localised yellow and red podzolic soils associated with shale lenses; siliceous sands and secondary yellow earths along drainage lines.
3. Lambert: this highly erosive soil type lies on the undulating to rolling low hills (slopes of less than 20 percent) of the Hawkesbury Sandstone. The soils are characteristically shallow (less than 50 centimetres), discontinuous earth soils and yellow earths on crests and on the inside of benches; shallow (less than 20 centimetres) siliceous sands/lithosols on leading edges; shallow to moderately deep (less than 150 centimetres) leached sands, grey earths and gleyed podzolic soils in poorly drained areas; localised yellow podzolic soils associated with shale lenses.
4. Newport: this infertile and highly erosive soil lies on gently undulating plains to rolling rises (slope gradients of less than 10 percent) of Holocene sands mantling other soil materials or bedrock. The soils are shallow (less than 50 centimetres), well sorted siliceous sands overlying moderately deep (less than 150 centimetres) buried soils including yellow podzolic soils with sandy topsoils on crests and gentle slopes; deep (more than 200 centimetres) podzols on steep slopes, lower slopes and in depressions.
5. Oxford Falls: this poorly drained, highly erosive and permeable relatively infertile soil lies on the hanging valleys (with slopes of less than 15 percent) on Hawkesbury Sandstone. This soil type is characterised by moderately deep to deep (50 to 150 centimetres) earthy sands, yellow earths, siliceous sands on slopes; deep (more than 200 centimetres) leached sands, podzols and grey earths on valley floors.
6. Blacktown: this poorly drained and infertile soil type lies on gently undulating rises (with slopes generally less than five percent but up to 10 percent) of the Wianamatta geological group. This soil type is characterised by shallow to moderately deep (less than 100 centimetres) red and brown podzolic soils on crests, upper slopes and well drained areas; deep (150-30 centimetres) yellow podzolic soils and sloths on lower slopes and in areas of poor drainage.
7. Tuggerah: this infertile soil type lies on gently undulating to rolling coastal dunefields (slope gradients generally one to 10 percent). The soils are deep (more than 200 centimetres) podzols on dunes and podzol/humus podzol intergrades on swales. This soil type is highly susceptible to wind erosion and is highly permeable.

8. Birrong: this fairly infertile soil type lies on level to gently undulating (slope gradients of less than three percent) alluvial floodplains and is dominated by silt and clay sized alluvial materials derived from the Wianamatta geological group. The soils are characteristically deep (more than 250 centimetres) yellow podzolic soils and yellow solodic soils on older alluvial; deep (more than 250 centimetres) solodic soils and yellow solonetzic soils on the existing floodplain. It is subjected to localised flooding, erosion and waterlogging.
9. Warriewood: this water logged soil type lies on level to gently undulating swales, depressions and infilled lagoons (slopes of less than three percent) on Quaternary sands. The soils are characteristically deep (more than 150 centimetres), well sorted, sandy humus podzols and dark, mottled siliceous sands, overlying buried acid peats in depressions; deep (more than 200 centimetres) podzols and pale siliceous sands on sandy rises.

Today the soils in the catchment differ in many ways from their original condition. The major changes have resulted from the wide-spread clearing of native vegetation and the filling of low lying areas along the River. Land clearing has resulted in exposure of the topsoil to surface run-off, decrease in levels of infiltration, and an increase in run-off velocity.

Most of the original low-lying saline mangrove and mudflat areas adjacent to the river have been drained and reclaimed. Reclamation has led to many problems, notably:

- Ground Instability, which often lasts for many years after the fill material is deposited. It can take up to ten years for dredged silt which has been covered with clay based material to sufficiently subside to the point where it is able to carry vehicular traffic. This effectively renders the land geotechnically unsafe as construction sites (Total Environment Centre 1976);
- Contamination from garbage and other polluted fill materials that continue to leach into the river for many years. Marine based sediments can have a similar effect if they contain iron pyrite which, when oxidised, can also leach into the surrounding soils (acid sulphate soils); and
- Re-establishment by native vegetation is often difficult if not impossible to achieve on reclaimed land. There are a number of factors responsible for this including changes in soil chemistry, water absorption, and soil horizon structure. The heterogeneous (that is, variable) composition of most fill material, unlike the relatively homogenous natural soils, may vary with each load of material moved.

2.7 Vegetation

The aquatic and terrestrial ecosystems have been significantly altered since European settlement. The original native plant communities in the catchment have been identified based on historical records, community remnants and soil landscape modelling (Clouston 1997a). Seven communities have been identified as follows:

- Clay Plain Scrub Forest - This community was originally found along the broad, shallow valleys of the upper Cooks River and Wolli Creek on Wianamatta Shale.

The community structure was open-forest to low woodland, generally with a characteristic shrubby or scrubby understorey usually dominated by paperbarks such as Melaleuca nodosa and Melaleuca decora. Canopy species would have included ironbarks such as Broad-leaved Ironbark (Eucalyptus fibrosa), Grey Gum (Eucalyptus punctata), Woollybutt (Eucalyptus longifolia) and Turpentine (Syncarpia glomulifera) (Clouston 1997a);

- Turpentine - Ironbark Forest - This community was commonly found throughout much of the northern, western and southern sections of the Cooks River Catchments on the well-drained soils of the Wianamatta Shale. The dominant canopy species included Turpentine and Broad-leaved Ironbark and Grey Ironbark (Eucalyptus paniculata), with a generally grassy understorey (Clouston 1997a);
- Cooks River Sandstone Vegetation - This community was commonly found on the Hawkesbury Sandstone from Dulwich Hill through Earlwood to Bexley North and Arncliffe. Vegetation structures would have ranged from forest on the sheltered slopes to woodland and heath on the exposed sites, as well as local sedge swamps. Forest trees would have included Blackbutt (Eucalyptus pillularis), Sydney Peppermint (Eucalyptus piperita) and Smooth-barked Apple (Angophora costata) (Clouston 1997a);
- Floodplain Forest - This community was found on the floodplain on the Cooks River, enclosed within a sandstone valley, that extended from Canterbury to Tempe. The forest here would have been dominated by Swamp Oak (Casuarina glauca), with patches of Swamp Mahogany (Eucalyptus robusta) and Paperbarks (Melaleuca sp) (Clouston 1997a);
- Freshwater and Brackish Swamps - These communities were found on deep sandy country behind Lady Robinsons Beach and draining to Muddy Creek were swamps and heath areas occur (Clouston 1997a);
- Mangroves and Saltmarsh - Mangrove and saltmarsh flats were common in the estuary of the Cooks River, downstream of Tempe. These areas have now been filled, and developed and in places the channel of the river diverted. Grey Mangroves (Avicennia marina), still occur along Wolli Creek, Muddy Creek as well as along the Cooks River as far upstream as Canterbury. The only remaining saltmarsh remnants occur along Wolli Creek and Muddy Creek, and within the Eve Street wetlands, Firmstone Gardens, and the Landing Light wetlands.
- Banksia Scrub - The Banksia Scrub community was commonly found on Pleistocene/Holocene sand sheet of the eastern suburbs extends westward into the Cooks River Catchment from Surrey Hills to Mascot. This area drains to Sheas Creek. Vegetation here would have been Banksia Scrub with Banksia aemula as the dominant species (Clouston 1997a).

Further detail of the ecological values of the Cooks River is provided in Chapter 3.

2.8 Stormwater Drainage System

The Cooks River channel is so highly modified it functions more like a stormwater drainage system than a river system. Virtually the entire length of the River is concrete lined or piped, and the channel itself has been straightened and realigned in a number of places.

A number of authorities are responsible for the management of the river, its tributaries and the stormwater system. The upper drainage reaches are the responsibilities of the Councils whereas most of the main stormwater channels are the responsibility of Sydney Water Corporation. Cooks River above Church Street, Canterbury comes under the jurisdiction of Sydney Water but below Church Street, the reaches are the responsibility of the Department of Public Works and Services (Webb 1994). Other authorities with responsibilities for drainage include Waterways Authority, Roads and Traffic Authority, and Rail Access Corporation (Water Board, undated).

The existing stormwater infrastructure is illustrated in *Figure 4* and discussed on a sub-catchment basis in the sections below.

2.8.1 Upper Cooks River

The Upper Cooks River sub-catchment drains the suburbs of Greenacre, Chullora, Strathfield, South Strathfield, Wiley Park and Punchbowl, within the Local Government Areas of Bankstown and Strathfield. The south-east corner of Rookwood Cemetery, within Auburn Local Government Area, also drains to the Upper Cooks River.

The drainage system comprises a network of minor street drains which are the responsibility of the Councils, and major trunk drainage lines which are generally controlled by Sydney Water Corporation. The main exceptions are the channels within Chullora Workshops and the Enfield Marshalling Yards which are controlled by Rail Access Corporation, and unlined watercourses, such as those through Strathfield Golf Course.

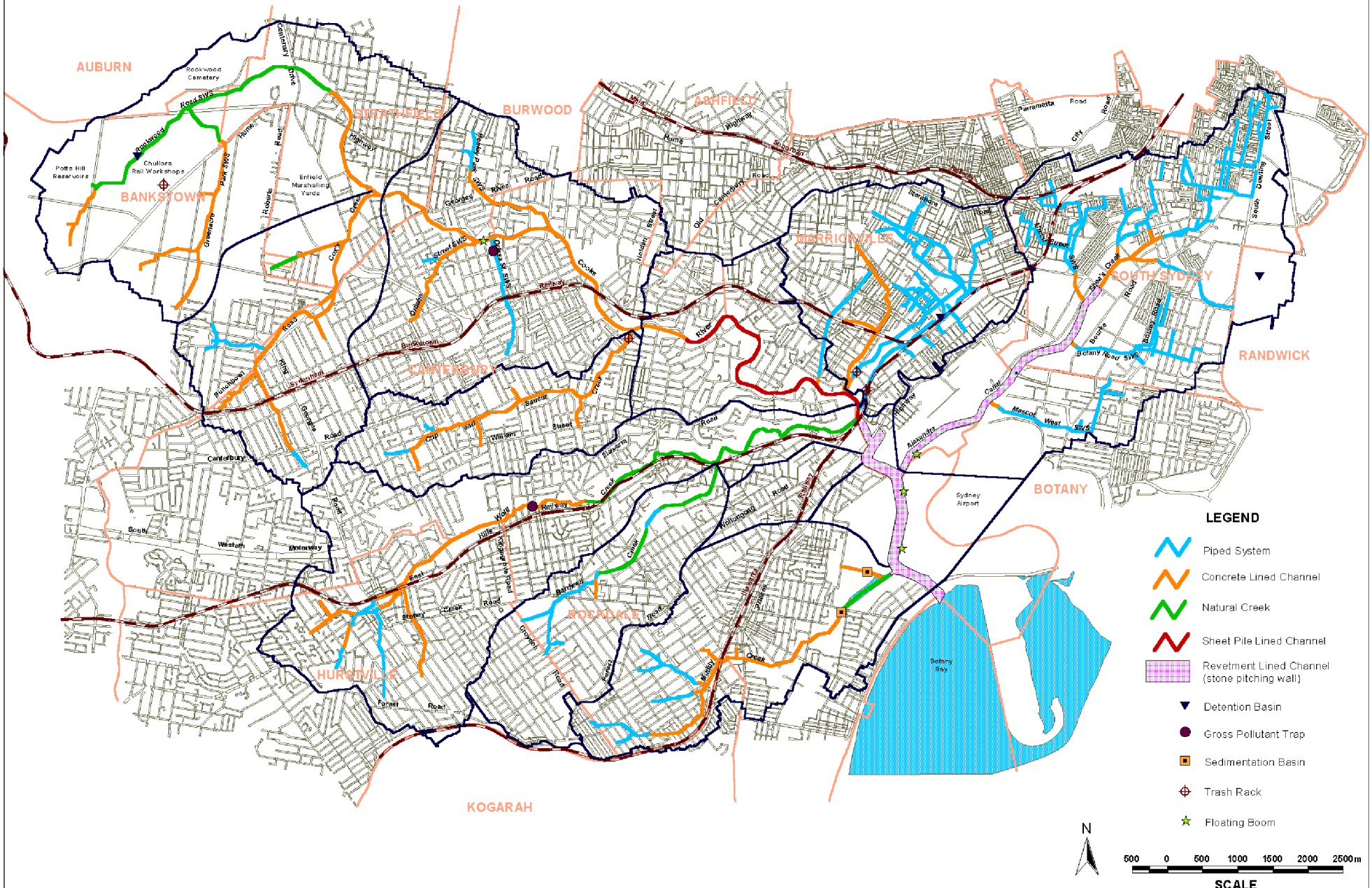
Most of the trunk branches are concrete/brick lined and were constructed in the 1930's, while the Cooks River Branch downstream of Strathfield Golf Course (Hedges Avenue, Strathfield) was constructed in the 1960's. There are four main drainage lines in the sub-catchment, these include: the Cooks River Branch, Rookwood Road Branch, Greenacre Park Branch and Punchbowl Road Branch (Water Board 1991).

Cooks River Branch (includes Freshwater Creek)

The upper reach of this branch through Strathfield Golf Course is unlined. Downstream of the golf course (Hedges Avenue), the river is an open lined channel which continues past the Upper Cooks River Catchment outlet (Water Board 1991).

Figure 4

Cooks River Catchment
Existing Stormwater Infrastructure



Rookwood Road Branch

This is generally an open lined channel draining parts of the Potts Hill reservoir and Bankstown north-east through to the Chullora Workshops. Downstream of the Chullora Workshops the channel joins the Greenacre Park Branch before flowing into the Cooks River Branch (Water Board 1991).

Greenacre Park Branch

This branch drains parts of Chullora and Greenacre to the north-east. Pipes and channels in the upper areas drain into an open lined channel which extends from Greenacre Road to the Hume Highway. Downstream of the Highway, the channel enters through the Chullora Workshops and is mostly unlined (Water Board, undated).

Punchbowl Road Branch (Cox's Creek)

This is generally an open lined channel draining parts of Lakemba, Greenacre, Wiley Park, Belfield and Enfield. Collector pipes and smaller channels feed into the main channel, which runs in a northerly direction to discharge into the Cooks River Branch at Water Street, Strathfield (Water Board 1991).

2.8.2 Cooks River (Cox's Creek to Cup & Saucer Creek Junctions)

The stormwater system from Cox's Creek to the Cup and Saucer Creek confluence drains the suburbs of Lakemba, Belmore, Strathfield, Belfield, Campsie, Enfield, and Croydon Park, within the Local Government Areas of Canterbury and Burwood. The system comprises a network of minor street drains which are the responsibility of the Councils, and trunk drainage lines which are generally controlled by Sydney Water Corporation. Culverts located under the railway crossings are the responsibility of Rail Access Corporation. There are four main drainage lines in the sub-catchment.

Cooks River Branch

The Cooks River is fully concrete lined to Beamish Street, Campsie. Thereafter the channel has concrete lined side walls and a natural invert.

Omaha Street Branch

This is generally an open lined channel draining parts of Lakemba, Belmore and Belfield before entering the Cooks River opposite Flockhart Park. There are a number of culverts which are controlled by Council (Water Board, undated).

Orissa Street Branch

This is a fully piped network which passes north, draining part of Campsie before discharging to the Cooks River at Fifth Avenue. Most of the main channel was constructed in 1918. The drainage in the upper catchment reaches is controlled by Canterbury Council (Water Board, undated).

A catchment management plan was prepared for the Orissa Street Branch by Sydney Water and Canterbury Council in 1990.

Henley Park Branch

This is generally an open channel draining part of Enfield and Croydon Park. The channel upstream of Tangarra Street was recently amplified and a detention basin constructed in Henley Park to protect downstream properties from frequent flooding. The channel enters the Cooks River just downstream of Brighton Avenue, Croydon Park (Water Board, undated).

2.8.3 Cup and Saucer Creek

Cup and Saucer Creek drains parts of Lakemba, Belmore, Clempton Park, Earlwood, Campsie, and Canterbury, mostly within the Canterbury Local Government Area. The sub-catchment extends from the Cooks River at Canterbury up to Sydney Water's Canarys Road reservoir near Roselands (Water Board 1992).

The creek is generally an open concrete drain constructed in the 1930's with 11 branch channels located in parkland and open space that join the creek along its length.

The main sections of these channels and the main trunk drainage are controlled by Sydney Water Corporation, but the local street drainage system is controlled by Canterbury Council (Water Board 1992).

From the upper end of the catchment down to Northcote Road, Canterbury, the channel is located between residential and industrial properties with very little natural floodplain. From Northcote Road to Fore Street the channel is mainly located in a well grassed parkland which forms a natural floodplain. There is a major sewer overflow outlet which enters the channel and a sewer aqueduct just upstream of Fore Street (Water Board 1992). The sewer aqueduct is a large concrete structure and is part of the Canterbury Submain. The open channel downstream of Fore Street extends past residential properties and through the parkland adjacent to the Cooks River confluence.

Features of the channel downstream of Fore Street include a trash rack, a drop in the invert of two metres where a waterfall once was located and channel walls formed of the natural rock formation (Water Board 1992). The remainder of the main channel consists of a mixture of open brick walled and concrete invert channel, Tonkin type channels and sections of covered channel.

2.8.4 Cooks River (Cup & Saucer Creek to Wolli Creek Junction)

The stormwater system from Cup and Saucer Creek to Wolli Creek drains the suburbs of Hurlstone Park, Dulwich Hill, and Marrickville, within the Local Government Areas of Marrickville and Canterbury. The system comprises a network of minor street drains which are the responsibility of the Councils. Sydney Water Corporation controls the Marrickville Valley Stormwater Channels, to the north of the Cooks River.

The Cooks River over this section has a concrete embankment lining and an earth bottom ending near Church Street, Canterbury (Soil Conservation Service 1991). The

river bank downstream of this point is mostly reinforced with sheet piling and is the responsibility of Public Works (Total Environment Centre 1995).

Marrickville Valley Branch

The Eastern, Central, and Western Channels are three drainage systems which combine to drain the areas of Marrickville, Enmore, Newtown, St Peters, Sydenham and Tempe.

The Eastern Channel is generally a twin, open channel that enters the Cooks River near Tempe railway station. A detention basin located near Sydenham railway station forms part of this system (Water Board, undated).

The Central Channel is open at the upstream end, through railway land, and covered at the downstream end adjacent to Carrington Street. This system is controlled by two pumping stations which pump excess run-off to the Eastern Channel, and directly to the Cooks River (Water Board, undated).

The Western Channel comprises two systems including an open channel which enters the Cooks River at Mackey Park, and a tunnel which drains the top end of the catchment above Sydenham and Livingstone Roads, Marrickville (Water Board, undated).

2.8.5 Wolli Creek

Wolli Creek, with its tributary Bardwell Creek, drains the suburbs of Narwee, Penshurst, Hurstville, Beverly Hills, Kingsgrove, Bexley, Bardwell Park, Arncliffe and Turrella, within the Local Government Areas of Rockdale, Canterbury and Hurstville (Water Board, undated).

The stormwater system comprises a network of minor street drains which are the responsibility of the Councils, and main trunk drainage lines which are controlled by Sydney Water Corporation. These trunk drainage lines include underground and exposed concrete/brick rectangular channels which were constructed in the early 1940's.

Wolli Creek is a lined channel downstream of Kingsgrove Road to Bexley Road. Thereafter the lower reaches of the creek to the Cooks River is largely in a "natural" state forming a defined but winding watercourse through the Wolli Valley. The Creek continues in an east northeasterly direction, gradually widening until it enters the Cooks River at Tempe Railway Bridge (Water Board, undated).

Bardwell Creek

Bardwell Creek is the major tributary of Wolli Creek, with its confluence located at Arncliffe some 2.5 kilometres upstream of the Cooks River junction (Webb 1996).

The upper reaches of Bardwell Creek arise in Hurstville to drain in a north-easterly direction through the suburbs of Hurstville, Bexley North, Bardwell Park and Turrella. Upstream of Croydon Road, there are two sub-catchments drained by brick/concrete open rectangular channels. Downstream of Croydon Road, these two branches run in

box culverts before merging into a lined channel passing through culverts to Ellerslie Road. Downstream of Ellerslie Road, the creek runs in a semi-natural watercourse.

The open channel between Croydon Road and Ellerslie Road was constructed during the mid 1930's and is presently controlled by Sydney Water (Webb 1996).

2.8.6 Lower Cooks River (Wolli Creek to Botany Bay)

The Cooks River between Wolli Creek to Botany Bay drains Alexandria Canal and Muddy Creek, and part of Arncliffe. The river banks comprise a combination of stone block revetments and rocky shoreline (Soil Conservation Service 1991).

Most of the river bank was built between the late 1940's to the early 1950's as part of the river diversion works associated with the construction of the Sydney Airport. The mouth of the Cooks River was relocated 1.6 kilometres west to its current position during these works. The river section is currently controlled by Public Works and Department of Land and Water Conservation (Total Environment Centre 1995).

Bonnie Doon Branch

Bonnie Doon is an ill-defined catchment of one square kilometre between Wolli Creek and the Cooks River at Arncliffe within the Local Government Area of Rockdale. The area contains a piped drainage system which passes to the east through conduits across the Illawarra railway line. The bottom of the catchment is drained by the Bonnie Doon Channel which extends east of the railway line through Cahill Park, draining to the Cooks River. This system is managed by Rockdale Council.

2.8.7 Alexandra Canal/Sheas Creek

Alexandra Canal was constructed in the late 1800's along the line of Sheas Creek. It drains a catchment area of about 16.5 square kilometres comprising the industrial and residential suburbs of Waterloo, Alexandria, Redfern, and Moore Park within the Local Government Areas of Botany, Randwick, and South Sydney (Water Board, undated).

The Canal is a tidal channel approximately 60 metres wide, with a water depth between one and three metres. At the confluence of Sheas Creek with Alexandra Canal, the width of Sheas Creek is 12 metres and the invert of the channel is at 0.7 metres AHD.

The Canal is owned by Sydney Water who also control the four main trunk drainage systems that enter the Canal. Numerous minor drains in the Alexandra Canal sub-catchment are managed by South Sydney, Marrickville and Botany Councils. A Water Environment Plan to improve water quality in the Canal was prepared in 1997 (Hyder 1997). Sydney Airport is currently preparing its own Stormwater Management Plan.

The main drainage lines were constructed during the 1920s and early 1930s. However, significant upgrading and amplification of the lines have occurred since that time (Webb1991).

Botany Road Branch

This branch drains a predominantly industrial area west from Rosebery across the Canal.

Munni Street Branch

This branch drains the Erskineville/St Peters area extending up to the Eveleigh railway yards.

Mascot West Branch

This drains part of the Mascot industrial area, north of the airport.

Sheas Creek

Sheas Creek drains a catchment containing portions of the southern Sydney suburbs of Surry Hills, Alexandria, Waterloo, Zetland, Beaconsfield and Redfern. Sheas Creek has a catchment area of approximately 6.6 square kilometres to its confluence with Alexandra Canal (South Sydney 1997).

There are three main drainage reaches in this system including the Alexandria-MacDonaldtown Branch, Main Branch, and Victoria Branch (Webb 1991). The Main Branch is mostly a piped line from the upper region of Waterloo and Redfern which passes south-west to join the open channel downstream of Bowden Street. The Alexandria -MacDonaldtown Branch is a piped line from the north, whilst the Victoria Branch is a mostly a piped line from the east draining Zetland. Both these lines join the channel downstream of Bowden Street and continue for some 700 metres before joining Alexandra Canal.

2.8.8 Muddy Creek

Muddy Creek drains stormwater run-off to the north-east from the suburbs of Carlton, Kogarah, Rockdale, Banksia, Brighton-Le-Sands and Kyeemagh, within the Local Government Areas of Hurstville, Kogarah and Rockdale (Water Board, undated).

The upper catchment to Botany Street, Hurstville comprises a number of drainage systems combining open concrete channels and pipes (Australian Water and Coastal Studies 1997). Downstream of Botany Street, these systems join a main concrete channel that continues to the Cooks River. A number of open and piped side channels feed into the main channel. The lined channel from Hurstville to Bestic Street is generally under the control of Sydney Water, with the exception of some road and railway culverts (Water Board, undated). From Bestic Street to Barton Park, the waterway is under the control of the Waterways Authority.

Spring Street Branch

The Spring Street catchment is located within the Rockdale Local Government Area and drains the suburbs of Banksia and Rockdale to Muddy Creek. The catchment has an area of approximately 2.7 square kilometres.

The drainage system mainly consists of pipes with some box culverts in the lower catchment. The drainage system passes to the east across the Illawarra Railway Line through six stormwater culverts, to eventually join the open lined channel extending through to Muddy Creek (Lawson and Treloar 1997).

2.8.9 Stormwater Management Facilities

Based on the review of documents and a series of meetings with Councils, information has been collated on the range of stormwater quantity and quality management facilities presently used within the catchment. These facilities are summarised in *Table 2.4* and their location illustrated in *Figure 4*.

Table 2.4: Summary of Existing Structural Stormwater Management Facilities

Authority	Device Type	Constructed	Location
Sydney Water	Gross pollutant trap and Drainage Pumping Station/Detention Pit	1940	Brickpit, Railway Parade, Sydenham
Sydney Water	Drainage Pumping Station/Detention Pit	1963	Carrington Road, Marrickville
Bankstown City Council	Detention Basin	In design stage	Chullora Railway Workshops
Sydney Water	Trash Rack	1990	Cup & Saucer Creek-Canterbury
Sydney Water	Gross pollutant trap	1991	Orissa St Drain, Fifth Ave, Campsie
Sydney Water	Trash Rack	1991	Mackey Park, Marrickville
Sydney Water	Gross pollutant trap	1992	Wolli Creek, Kingsgrove
Cooks River Valley Association	Floating boom	1995	Fifth Ave, Campsie
Marrickville Council	Drainage Pumping Station /Detention Pit and silt screen	Date Unknown	May Road, St Peters
South Sydney Council	Gully Pit Traps	1997-8	80 percent of road drains throughout catchment
Canterbury Council	Pollutec Litter Trap	Planned	Tasker Park, Canterbury
Bankstown City Council	Trash rack	1996	Muir Road, Chullora
Canterbury Council	Pollutec litter trap	1996	Park, near Belmore Rugby League field
Marrickville Council	Pollutant trap	Planned	Tennyson St sub-catchment

3. Existing Catchment Conditions

3.1 Physical Environment

3.1.1 Hydrology

The hydrological response of a catchment is influenced by the degree and nature of development of the land surface, as well as by the soil and geological characteristics. The majority of the catchment is underlain by clay soils and sandstone contributing to low soil permeability. In contrast, the Alexandra Canal and Muddy Creek catchments are underlain by sandy soils, allowing greater soil permeability and reduced run-off from unsurfaced areas.

A very high proportion of the land surface of the Cooks River catchment is relatively impervious owing to its intensively urbanised nature. The pervious areas of the catchment are limited to the corridors of open space along the River and along Wolli Creek and Bardwell Creek, the formal parks, and residential gardens.

The concrete drainage lines, relatively low infiltration and soil storage capacity of the catchment results in a quick response to rainfall events. This is particularly significant in small frequent storm events and results in high flows and flooding in parts of the catchment. Generally the storm duration producing peak flows in the Cooks River is around two hours in a one in 100 storm (Webb 1996). Within the tributary branches in the lower catchment, the one hour storm produces peak flows in a one in 100 storm (Webb 1991).

Hydrology is greatly influenced by the urbanised nature of the catchment during the more frequent storm events. However, during major flood producing storms, there is likely to be little difference in hydrology between the urbanised Cooks River catchment and a saturated rural catchment (Public Works Department 1985).

3.1.2 Streamflow

There are no recorded streamflows along the main reach of the Cooks River and no gauging stations with rating curves for the area (Webb 1994). Limited streamflow data is available from short term sampling of the Cooks River tributaries, as shown in *Table 3.1*. The flow volumes were generally taken near the catchment outlets. *Table 3.1* is a synthesis of design peak flows and average observed flows for the Cooks River and its tributaries (determined by numerical modelling).

Table 3.1: Cooks River Streamflows

Catchment	Location	Average Daily Flow (m^3/s)	1 in 100 Year Design Peak Flow (m^3/s)
Upper Cooks River		0.10(1)	-
Cooks River	Brighton Ave, Campsie	-	400
Cup & Saucer Creek		0.07(1)	-
Wolli Creek		4.9(2)	290
Cooks River	Wolli Creek confluence	-	770
Bardwell Creek		-	80
Alexandra Canal/Sheas Creek		7.0(2)	160
Cooks River	Tempe	-	730
Bonnie Doon		-	30
Cooks River	Bonnie Doon confluence	-	820
Muddy Creek		-	150
Cooks River	Muddy Creek confluence	-	960
Cooks River	Breakwater	-	1010

Notes: (1)Sampling period from 1/1/94 to 30/6/94 (2) Sampling period from 1/1/94 to 31/12/94
References: Sydney Water Corporation (1994), Australian Water and Coastal Studies (1997), Webb (1991), Webb (1994) and Webb (1996).

Detailed investigation of flow characteristics has been undertaken for Alexandra Canal. There are a variety of water inflows to the Canal, including:

- tidal inflow estimated at 590 Ml per day;
- average run-off volume from the catchment of 28 Ml per day;
- groundwater flows to the Canal predicted to range from 9 Ml per day during dry weather to 12 ML per day during wet weather; and
- other discharges include licensed and potentially illegal discharges from individual premises (Hyder 1997).

Stormwater inflows are considered to represent around two percent (6 Ml) of the total inflows to the canal during a tidal cycle in dry weather (Hyder 1997).

3.1.3 Tidal Regime

The tidal range within Botany Bay at the mouth of the Cooks River is between 0.60 metres AHD and -0.60 metres AHD (Hyder 1997). The River is quite shallow for most of its length, and has water depths generally in the range of one to three metres (Total Environment Centre 1995).

The tidally affected portion of the Cooks River extends from the River's mouth to approximately 11 kilometres upstream near Enfield. The tidal influence on the tributaries extends up to Huntley Street on Alexandra Canal, Bestic Street on Muddy

Creek, and to Nanny Goat Hill on Wolli Creek (NSW Environment Protection Authority 1997). These tidal limits are illustrated in *Figure 5*.

Results from tidal gauging of the Cooks River on 24 January 1990 are presented in *Table 3.2*. The data show tide levels at four locations along the river:

- Kyeemagh - Endeavour Bridge 150 metres from Botany Bay;
- Tempe - Midway between the Cooks River Bridge and the Giovanni Brunetti Bridge approximately 2.3 kilometres upstream from Botany Bay;
- Undercliffe - 250 metres upstream from the Illawarra Road Bridge, approximately five kilometres upstream from Botany Bay; and
- Canterbury - Canterbury Road Bridge.

Table 3.2: Summary of Tide Level Data – 24/1/90

Location	Low Water Level (mAHD)	High Water Level (mAHD)
Kyeemagh	-0.56	0.22
Tempe	-0.53	0.23
Undercliffe	-0.52	0.23
Canterbury	-0.51	0.16

Reference: Public Works/MHL, 1991

Some general tidal data at Illawarra Road, Undercliffe are presented in *Table 3.3*. This information was not available for the other monitoring locations.

Table 3.3: Cooks River Tidal Flowrates at Illawarra Road, Undercliffe

Tidal Condition	Level at Illawarra Road (mAHD)
MHHWSS (Mean Higher High Water Spring Solstice- level above which the tide seldom rises)	1.12
Mean High Water (average of all high tides)	0.11
Indian Spring Low Water (approx. the lowest tide that will occur)	-0.78

Reference: (Soil Conservation Service 1991)

The flushing times for the mouth and lower reaches of the Cooks River and the lower reaches of Alexandra Canal are between one and five days. Botany Bay has a short flushing time of approximately one day (Hyder 1997).

There is little data available on the tidal regime of the tributaries, except for Alexandra Canal. The tidal pattern of the Canal, measured 1.8 kilometres upstream of the confluence with the Cooks River, range from 0.60 metres AHD to -0.67 metres AHD. The Canal is considered saline for its entire length and has a flushing time estimated between five and 10 days (Hyder 1997). The tidal flow rates in Alexandra Canal are shown in *Table 3.4*.

Table 3.4: Tidal Flowrates in Alexandra Canal

Tidal Condition	Average Flow for Tidal Cycle (m^3/s)	Peak Flow During Tidal Cycle (m^3/s)
Spring Tides	13.7	20.6
Neap Tides	9.9	15.0
Highest Astronomical Tide	20.7	31.0

Reference: (Hyder 1997)

3.1.4 Mainstream Flooding

Mainstream flooding occurs along sections of the Cooks River as a result of past residential and industrial development of the natural floodplain and modifications to the River channel. Flooding along the Cooks River and its tributaries can be influenced by several factors including:

- tides (particularly tidal and storm surges);
- catchment inflows (for example, stormwater, direct run-off, licensed discharges);
- flow obstructions (for example, developed floodplains, hydraulic structures, overgrown vegetation); and
- channel bathymetry.

A summary of the main areas affected by mainstream flooding and potential causes are shown in *Table 3.5*. Future developments of the natural floodplain (such as that proposed for the M5 motorway) may increase the frequency of flooding events and should be prevented where possible.

Table 3.5: Areas Affected by Mainstream Flooding

Location	Area affected	Potential Causes
Upper Cooks River	Strathfield	Overgrown vegetation along stream sections and culvert restrictions
Cooks River (Cox's Creek to Cup & Saucer Creek)	Canterbury, Campsie,	Inadequate channel size, inadequate detention and sedimentation.
Cup & Saucer Creek	Campsie, Earlwood	Industrial development ; Sewer; Culvert restrictions
Cooks River (Cup & Saucer Creek to Wolli Creek)	Earlwood, Marrickville, Dulwich Hill	Inadequate channel size and inadequate detention
Wolli Creek	Turrella, Bexley North	Overgrown stream section; Residential development; Road crossings and culvert restrictions
Bardwell Creek	Bexley, Bexley North	Bardwell Valley Golf Course; Weir; Residential development; Road crossings; Railway underbridge
Lower Cooks River (Wolli Creek to Outlet)	Tempe, North Arncliffe, Arncliffe	Sewer line; Limited overbank area
Muddy Creek	Banksia	Railway; Culvert restrictions; Road and pedestrian bridges; Development; Sewer line.

Location	Area affected	Potential Causes
Sheas Creek	Alexandria	Inadequate capacity of culverts and channels and development of the natural floodplain area.

Upper Cooks River

Significant flooding occurs along the Cooks River in Strathfield at Pemberton Street/ Ada Avenue, Hedges Avenue/Augusta Street, and Fitzgerald Avenue (Clouston 1997a). Potential causes of this flooding include the heavily overgrown vegetation along natural stream sections and culvert constrictions within the railway properties.

Flood mitigation measures proposed in the *Upper Cooks River Sydney Water Corporation No.38 Catchment Management Study, 1991* suggested increasing the culvert capacities, providing detention storage, and the restoration and enlargement of unlined channels (Water Board 1991).

Cooks River (Cox's Creek to Cup & Saucer Creek)

In a 1 in 100 year flood, three residential buildings and a number of industrial buildings would be inundated by floodwaters (Webb 1994). The main areas affected include Gordon Street, Campsie, Phillips Avenue and Charles Street, Canterbury. The *Cooks River Floodplain Management Plan, 1997* gave a high priority for the provision of flood awareness programs, flood hazard notification, and redevelopment or the construction of a minor levee in Gordon Street.

Cooks River (Cup & Saucer Creek to Wolli Creek)

In a 1 in 100 year flood, 70 residential buildings and a number of commercial buildings would be inundated by floodwaters (Webb 1994). The main areas where damage is expected to occur include Bankside Avenue to Pine Avenue, Earlwood, Illawarra Road/Wharf Street, Marrickville, Riverside Crescent, Dulwich Hill, and Lang Road, Earlwood. Other affected areas occur in Hurlstone Park, Marrickville, and Earlwood.

The *Cooks River Floodplain Management Plan, 1997* gave a high priority for the provision of flood awareness programs, flood hazard notification, rezoning, and the revision of development controls (Webb 1994).

Cup and Saucer Creek

Areas where property flooding is known to have occurred include Potter Avenue, Earlwood (where five properties were affected), Bexley Road, and Scahill Street, Campsie (Water Board 1992). The cause of flooding was partly attributed to several obstructions near the watercourse including a sewer aqueduct, the culvert at Bexley Road, industrial development up to the channel walls between Alfred Street and Kingsgrove Road, and many access bridges (Water Board 1992).

Wolli Creek

The main areas where flooding is a known problem occur at Henderson Street, and Bexley Road, Bexley North. Occasional flooding occurs along the drainage channel, particularly in the Kingsgrove industrial area from the Crescent to Kingsgrove Road

(Soil Conservation Service 1991). An estimated number of 11 properties are expected to be inundated above the floor level, and 22 properties affected by yard inundation during a 1 in 100 year flood. Almost all of the flood liable development lies in the Rockdale Local Government Area.

Potential for flooding also exists at the mangrove tidal flats of Wolli Creek, near the South Western Suburbs Ocean Outfall Sewer in Turrella. Flooding in the area would inundate part of the industrial land at Unwin Street (Soil Conservation Service 1991).

A number of factors cause hydraulic restrictions in the watercourse including the heavy overgrowth of vegetation along the channel, developments along the floodplain, and various road crossings (Webb 1996).

Floodplain management strategies for these areas have been investigated in the *Wolli Creek, Bardwell Creek, Bonnie Doon Channel and Eve Street/Cahill Park Catchments Floodplain Management Plan* for Rockdale Council (Webb 1998).

Bardwell Creek

The main areas where flooding is known to be a problem occur at Hillcrest Avenue, Bexley, Veron Road, Bexley, and Canonbury Grove, Bexley North. The areas downstream of Pile Street and between Croydon Road and Stoney Creek Road, Bexley could also be affected by flooding. An estimated number of seven properties are expected to be inundated above the floor level, and 29 properties affected by yard inundation during a 1 in 100 year flood.

There are several features causing flow constrictions along the watercourse, these include a low level weir located some 300 metres upstream of the Wolli Creek confluence, various road crossings, and a railway underbridge. The overbank areas largely comprise cleared parkland however some area is filled to form part of Bardwell Valley Golf Course, and a few residential developments occur close to the creek.

Floodplain management strategies for these areas have been investigated in the *Wolli Creek, Bardwell Creek, Bonnie Doon Channel and Eve Street/Cahill Park Catchments Floodplain Management Plan* for Rockdale Council (Webb 1998).

Lower Cooks River

In a 1 in 100 year flood three residential buildings and one commercial building at Bay Street, Tempe would be inundated by floodwaters leaving the Cooks River (Webb 1994). The *Cooks River Floodplain Management Plan, 1997* gave a high priority for the provision of a flood awareness program and in promoting the redevelopment of the area (Webb 1994).

Some areas near the Bonnie Doon Channel in Arncliffe can potentially flood from floodwaters leaving Wolli Creek and from the Channel itself. The main areas affected include Gertrude Street/Levey Street, Innesdale Road, and North Arncliffe between the East Hills and Illawarra railway lines. An estimated number of 101 properties are expected to be inundated above the floor level, and 172 properties affected by yard inundation during a 1 in 100 year flood (Webb 1996). Potential flow restrictions

along the Bonnie Doon channel include the sewer line, which crosses the channel downstream of Wollongong Street, and limited overbank areas.

Floodplain management strategies for these areas have been investigated in the *Wolli Creek, Bardwell Creek, Bonnie Doon Channel and Eve Street/Cahill Park Catchments Floodplain Management Plan* for Rockdale Council (Webb 1998).

Muddy Creek

There are a number of potential flow obstructions along Muddy Creek. These include: road and pedestrian bridges (for example, Bridges at the Princes Highway, Bay Street and Bestic Street); railway culverts near Frys Reserve; the sewer line upstream of the Princes Highway; and properties located on the floodplain (Australian Water and Coastal Studies 1997).

During significant floods it is possible that some water overflows out of Muddy Creek to Scarborough Ponds, which is outside the Cooks River catchment (Australian Water and Coastal Studies 1997).

Sheas Creek

A main problem area for flooding occurs in the vicinity of the open watercourse between Wyndham Street and Bowden Street, Alexandria. There is no significant floodplain in the area.

3.1.5 Local Flooding

A problem faced by some areas of the catchment is the poor condition and low capacity of the existing stormwater infrastructure, much of which is over 50 years old. The infrastructure was built to cater for a lower level of development and to standards which were valid or within budgetary constraints at the time (Marrickville Council 1997). As a result, many drains now overflow on a regular basis, statistically once every two years (although it may not necessarily flood every two years) (Marrickville Council 1997).

At best, the older systems were designed for the 1 in 10 year flood event. This means that storms in excess of the system capacity will travel overland along the path of least resistance. This leads to localised flooding of roads and properties (Canterbury City Council 1997).

Local flooding usually occurs once the capacity is exceeded in limited overland flow paths and where limited downstream inlet capacity exists, resulting in rising water levels (Marrickville Council 1997).

Upper Cooks River Catchment

Areas of local flooding occur in Lakemba at Punchbowl Road/Juno Parade intersection, Wangee Road, and Hampden Road, and Punchbowl at Punchbowl Road near Cornelia Street. Flooding in these areas are generally caused by inadequate road culverts and drainage around the Punchbowl Road stormwater channel (Soil Conservation Service 1991).

Localised flooding also occurs along the Greenacre Park channel, extending upstream from the railway culvert in Chullora Workshops, Como Road, Shellcote Road and Tennyson Road, Chullora. This flooding is attributed to deficient culverts in the railway land, and inadequate street culverts and drainage network. Over 30 houses have known to flood in the area (Soil Conservation Service 1991).

Bonnie Doon Catchment

Local flooding has occurred in the upper Bonnie Doon catchment causing the inundation of four properties and ponding in roads.

Significant overland flows through the catchment have been predicted in the areas east of Dowling Street, and west of the railway line. The main areas in the upper catchment where flooding is a known problem occur at Kembla Street, Kelsey Street, and Wollongong Road (Lawson and Treloar 1997).

Muddy Creek Catchment

Within the Muddy Creek sub-catchment, flooding occurs in Hayburn Avenue and The Strand, Rockdale as a result of developed a floodway and low floor levels of properties near the trunk drainage. Frys Reserve in Rockdale also receives flooding, some areas upstream of the reserve receive minor flooding. During less frequent storm events, the road approaches and railway underpass are inundated (Soil Conservation Service 1991).

The Spring Street drain has insufficient capacity to convey storm flows from design events of frequency greater than the 1 in 5 year flood (Lawson and Treloar 1997). Local flooding occurs at seven main locations with the Spring Street sub-catchment, typically within local depressions and street intersections. The main flow restriction in the catchment is caused by the culverts at the railway underpass (Lawson and Treloar 1997).

Sheas Creek Catchment

The West Kensington area has been affected by local flooding in the past. There are some 27 houses where above floor level flooding has occurred, and a further 56 properties affected by general property flooding (Public Works Department 1985b).

Along the Sheas Creek trunk drain flooding is generally caused by inadequate capacity of the channels and culverts to cater for run-off from existing development, and from development occurring in the floodways and depressions (Soil Conservation Service 1991). Various locations such as Mount Street; Boronia Street, Redfern; Joynton Street, Zetland; and Bourke Street, Redfern have reported property inundation as a result of overland flows and pit surcharging.

3.1.6 Water Quality

Water quality is a widely used indicator for providing information on the health of an aquatic ecosystem and the local catchment. The water quality within the Cooks River is affected by all activities and management practices within the catchment. Many pollutants from catchment activities are transported by stormwater into the river system.

Monitoring of water quality within the Cooks River catchment has been undertaken over twenty years. However, this has been undertaken by many different authorities for different purposes, and the location and level of monitoring, and the range of pollutants measured have not been consistent. Consequently, it is not possible to provide comment, based on scientific sampling and analysis, on long term trends for this diverse range of catchments. There is sufficient information available to indicate that the catchment has experienced high levels of pollutants for long periods of time. While past pollution loads to the Cooks River have been significant, there is some evidence that water quality is improving, at least for some key toxicants.

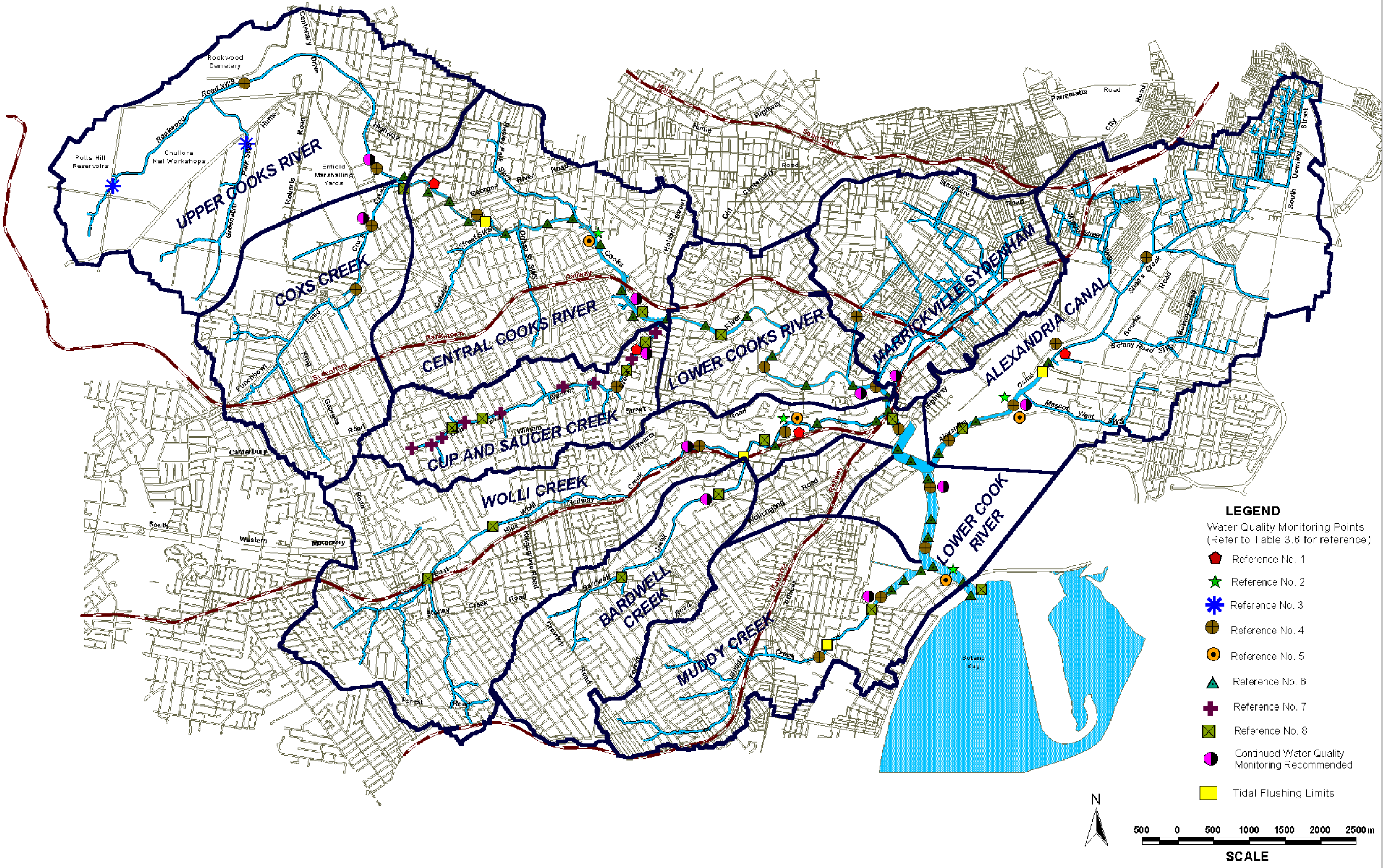
Table 3.6: Key Water Quality References

Report	Monitoring Period	No. Of Sample Sites in Cooks River Catchment	Parameters Measured	Reference
Stormwater Monitoring Project, 1994 Annual Report, Sydney Water	1994	4	Physico-chemical & bacteriological	1
Sydney Water Annual Environment Report 1997, Sydney Water	1996/97	4	Physico-chemical & bacteriological	2
State of the Catchments, 1997/98,Bankstown City Council	1997/98	2	Physico-chemical & bacteriological	3
Ecosystem Health, Report to the Committee, 1996, Cooks River Catchment Management Committee	1996	16 - 19	Physico-chemical	4
Licensing Sewerage Overflows - Environmental Impact Statement, Georges river and Southern Suburbs Geographic Area, Sydney Water	1993 onwards	4	Physico-chemical & bacteriological	5
Water Board. 1992b. *Dry and Wet Weather Intensive Water Quality Samples, Cooks River (15 January and 10 February 1992), Interpretive Report*.	1992	35	Physico-chemical & bacteriological	6
Water Board. 1992a. *Cup & Saucer Creek Stormwater Catchment Management Study*, Volume 1	1990/91	9	Physico-chemical & bacteriological	7
Scientific Services. 1991. *Water Quality in the Cooks River, February 1990 to June 1990*	1990	4	Physico-chemical & bacteriological	8

The Cooks River continues to suffer from poor water quality most of the time, although the public perception is that the water quality in parts of the river is

Figure 5

Cook River Catchment
Water Quality



improving (Total Environment Centre 1995). The existing water quality in the catchment has been assessed based on review of water quality sampling at sites shown on *Figure 5*. Sydney Water have undertaken the most extensive water quality sampling within the Cooks River System with additional sampling undertaken by Councils, the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996), and the Total Environment Centre (Total Environment Centre 1995).

A summary of all the water quality for each of the key contaminants is provided in *Table 3.6*. These key water quality indicators, their sources and potential pollution problems are summarised as follows:

- Nutrients - Phosphorus and Nitrogen

  These nutrients are found in high levels in the Cooks River. Sources of the phosphorus and nitrogen found in stormwater include pets and birds, fertilisers, detergents, and sewage discharges throughout the catchment. Golf courses and suburban gardens can be major sources of these nutrients. High levels of nutrients cause excessive growth of aquatic vegetation and can result in the development of algal blooms. This is of particular concern as species such as blue green algae in high concentrations are potentially toxic. The guideline levels for protection of freshwater and marine ecosystems are listed in *Table 3.12*.

- Chlorophyll-a

  The level of algal growth in the waterways is estimated by measuring chlorophyll - a. The recommended maximum level for the protection of aquatic ecosystems is 10 micrograms per litre (ANZECC, 1992). High levels of chlorophyll-a at or approaching bloom status, are indicated by chlorophyll-a levels greater than 20 micrograms per litre. Levels of chlorophyll-a are greater than 20 micrograms per litre in most sections of the Cook River and some evidence of algal blooms has been recorded.

- Faecal Coliforms

  High levels of faecal coliforms have been found in the Cooks River and are considered a key indicator of sewage overflow and seepage into the waterways. Bacteria occur naturally in soils and are commonly found in waterways. The bacteria of concern are those associated with faecal matter and other pathogens that represent a health risk and can make bathing waters and shellfish consumption unsafe. A Recreation guideline levels of faecal coliforms safe for swimming and boating within the waterways are less than 150 and 1000 colony forming units per 100 millilitres respectively based on data from five samples per month (ANZECC, 1992). Average levels of faecal coliforms exceed 1000 colony forming units per 100 millilitres in all sub-catchments of the Cooks River *Table 3.12*. The major sources of bacteria are sewage overflows, defective sewerage systems, illegal connections to stormwater drains and animal wastes including that of domestic pets.

Table 3.12 :

- Dissolved Oxygen

  Dissolved oxygen in waterways is vital for the maintenance of beneficial aquatic organisms. Dissolved oxygen levels vary diversely, naturally with temperature and salinity, and are greatly influenced by biological activities. ANZECC (1992) recommend that for the protection of aquatic ecosystems dissolved oxygen should not fall below six milligrams per litre or 80-90 percent saturation. Overloading the river system with organic materials, sewage, and food wastes can lead to depressed levels of dissolved oxygen and may result in ecological impacts including fish kills. Dissolved oxygen levels vary greatly in the Cooks River with depleted levels occurring in the lower estuarine sections of the River.

- Toxicants

  A number of chemicals of concern may be found in elevated concentrations in urban run-off. These include organic toxicants such as pesticides and herbicides which are toxic in large doses and may accumulate in the food chain. Their over use or misuse throughout the catchment is a key source of pollution. Other toxicants include petrols, oils, and grease and carcinogenic compounds such as PAH's and PCB's.

  Heavy metals including lead, mercury, zinc and copper are also found in high levels in stormwater. These compounds are washed into the stormwater drainage system after rain and may concentrate in sediment and bioaccumulate in living organisms. Atmospheric discharges from industry and vehicle emissions (particularly lead petrol emissions) are major sources of this type of run-off contamination. There are a range of guidelines for concentration of these toxicants which are protective of aquatic ecosystems. Toxicants have been measured in the water quality and sediments of the Cooks Rivers in elevated levels. Sediments in the Alexandra Canal, in particular, have been found to include all the above heavy metals together with organochlorine compounds, high concentrations of oil and grease and PAH's. (Reference can be made to *Section 3.1.*10 for comments on specific catchments.) A number of recent fish kills which have occurred in the River have been attributed to use of pesticide within the catchment.

- Suspended Solids or Turbidity

  Suspended solids include sediments washed from building sites, soil erosion, and all particulate matter in the water column. When present in excessive amounts, suspended solids can reduce light penetration, cause sedimentation of waterways and can act as transporting mechanisms for other pollutants. Suspended solid levels in the water column are the main determinant of turbidity. Some waterways are naturally more turbid than others and the recommended guideline for turbidity is less than 10 percent change in seasonal mean (ANZECC, 1992). Results for all the Cooks River catchments indicate results well outside this guidelines.

- Water Acidity (pH)

  Many species of native flora and fauna have adapted to a narrow range of water acidity. Changes in water pH may cause native flora and fauna to die or fauna to

move out of the area affected, and may favour opportunistic pest and weed species. Any increase or reduction in acidity may mobilise toxic chemicals, including heavy metals, oxides of nitrogen and sulphur in the water body and other inert chemicals deposited in bottom sediments of waterways. The pH range considered protective of aquatic ecosystems is 6.5-9.0 in fresh waters (ANZECC, 1992). Results for all the Cooks River catchment indicate a general compliance with this guideline.

In addition to the range of water quality indicators discussed above another key pollutant of the Cooks River is litter. Much of the pollution present in the catchment could also be associated with litter from inappropriate rubbish bin use, commercial activities and roads. Surface litter can include fast food packaging, polystyrene cups, plastics, aluminium cans and paper which accumulate in waterways and can be ingested by or entangle wildlife. Litter results in a reduction of the visual amenity of a waterway and can present a risk for children playing along the foreshores.

3.1.7 Assessment Against Water Quality Guidelines

A water quality assessment has been undertaken for each sub-catchment of the Cooks River. Water quality indicators have been compared against guideline levels suitable for:

- Protection of Aquatic Ecosystems - Fresh Waters;
- Protection of Aquatic Ecosystems - Marine Waters;
- Primary Contact Recreation (suitable for swimming); and
- Secondary Contact Recreation (suitable for boating).

An assessment and subjective rating of available data against general guideline requirements is provided in *Tables 3 13* with a summary comparison in *Table 3.14*. The assessments in the tables are subjective indications based on the broad range of analyses available. Due to the scatter of sampling locations and inconsistent selections of analytes in the past, it is difficult to these assessments on any specific scientific / statistical data, or on a “percent of time compliant” basis. The results of this assessment are discussed for each sub-catchment below.

In the following sections the term “the Guidelines” is used to refer to the values for Protection of Aquatic Ecosystems for Fresh or Marine Waters (ANZECC, 1992). The locations of the sub-catchments discussed and the sampling sites are shown on *Figure 6*.

Upper Cooks River

This catchment represents the fresh water section of the Cooks River. The lower reach of this catchment, around the junction with Coxs Creek, was monitored in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board 1992b), with four monitoring sites in this area.

During dry weather these sites generally registered higher than guideline levels of pH, total nitrogen, ammonia and total phosphorous, with spikes of high levels of turbidity,

total nitrogen, non-filterable residue and BOD around the Georges River Road sampling point. The high pH could be due to leaching of lime from the concrete channels in this location and the high BOD could be related to an unidentified discharge/overflow event. During the wet weather sampling high turbidity, total phosphorous, total nitrogen and non-filterable residue results were noted.

If the Recreation Guidelines are applied to this stretch of the river the faecal coliforms guidelines are exceeded for both Primary and Secondary Contact recreation during dry and wet weather sampling. In this sub-catchment the high levels of turbidity, ammonia, nitrogen and BOD, together with the high range of dissolved oxygen levels (7.9 milligrams per litre to 21.2 milligrams per litre) indicate the possible existence of algae and their photosynthetic activity.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (CRCMC 1996) in 1996 included two sampling sites in this catchment at Rookwood and Strathfield. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, cadmium, lead, mercury and zinc; and also with pesticides (chlordane, dieldrin and DDT) and PCB's. High levels of oil and grease were also noted.

Table 3.13: Assessment of Water Quality against Guidelines

Ref. No.	Sub-Catchment	Weather	pH	Ammonia	Total Nitrogen	Total Phosphorus	Chlorophyll-a	Dissolved Oxygen	Salinity (conductivity)	Faecal Coliforms
6	Upper Cooks River	Dry	M	M	H	M	M	L	L	H
6	Upper Cooks River	Wet	L	L	H	M	L	L	L	H
8	Upper Cooks River	Dry	L	M	H	L	H	L	L	H
8	Upper Cooks River	Wet	L	M	H	H	-	L	L	H
3	Upper Cooks River	Dry	-	-	L	M	M	L	L	H
6	Central Cooks River	Dry	L	M	H	M	H	L	L	H
6	Central Cooks River	Wet	L	M	H	H	L	L	L	H
8	Central Cooks River	Dry	L	H	H	M	H	L	L	H
8	Central Cooks River	Wet	L	M	H	M	-	L	L	H
8	Cup & Saucer Creek (Lower)	Dry	L	H	H	L	M	L	L	H
8	Cup & Saucer Creek (Lower)	Wet	L	M	H	M	-	L	L	H
8	Upper Wolli Creek	Dry	L	L	H	M	M	L	L	H
8	Bardwell Creek	Dry	L	M	H	L	L	M	L	H
8	Bardwell Creek	Wet	L	H	H	L	-	L	L	H
6	Lower Wolli Creek	Dry	L	NR	H	L	H	H	NR	M
6	Lower Wolli Creek	Wet	L	NR	H	H	L	L	NR	H
8	Lower Wolli Creek	Dry	L	NR	H	L	H	H	NR	H

Ref. No.	Sub-Catchment	Weather	pH	Ammonia	Total Nitrogen	Total Phosphorus	Chlorophyll-a	Dissolved Oxygen	Salinity (conductivity)	Faecal Coliforms
8	Lower Wolli Creek	Wet	L	NR	H	H	-	H	NR	H
6	Lower Cooks River	Dry	L	NR	M	L	H	H	NR	M
6	Lower Cooks River	Wet	L	NR	H	H	L	L	NR	H
8	Lower Cooks River	Dry	L	NR	H	L	H	M	NR	H
8	Lower Cooks River	Wet	L	NR	H	M	-	M	NR	H
6	Alexandra Canal	Dry	L	NR	H	M	H	H	NR	H
6	Alexandra Canal	Wet	L	NR	H	M	H	L	NR	H
8	Alexandra Canal	Dry	L	NR	H	L	H	M	NR	H
8	Alexandra Canal	Wet	L	NR	H	M	-	H	NR	H
6	Muddy Creek	Dry	L	M	H	L	L	M	L	H
6	Muddy Creek	Wet	L	M	H	H	L	-	L	H
8	Muddy Creek	Dry	L	M	H	L	H	L	L	H
WATER QUALITY OBJECTIVES										
Fresh Waters:										
	Aquatic Ecosystem Protection		6.5-9	80-2500	100-750	10-100	2-10	> 6	150000	
	Primary Contact Recreation		5-9	NR	NR	NR	NR	NR		< 150
	Secondary Contact Recreation		5-9	NR	NR	NR	NR	NR		< 1000
Marine Waters:										
	Aquatic Ecosystem Protection		< 0.2pH Unit Change	NR	10-100	5-15	2-10	> 6	NR	NR
Ratings			L = 6.5 - 9	L = < 80	L = < 100	L = < 100	L = < 10	L = > 6	L = < 150000	L = < 150

Ref. No.	Sub-Catchment	Weather	pH	Ammonia	Total Nitrogen	Total Phosphorus	Chlorophyll-a	Dissolved Oxygen	Salinity (conductivity)	Faecal Coliforms
			M = 5-10	M = 80-2500	M = 100-750	M = 100-200	M = 10-20	M = 5-6	M = 150000-250000	M = 150-1000
			H = < 5 > 10	H = > 2500	H = > 750	H = > 200	H = > 20	H = < 5	H = > 250000	H = > 1000

Table 3.14: Summary of Water Quality Against Guidelines

Ref. No.	Sub-Catchment	Weather	Aquatic Ecosystem Health (Freshwater)	Aquatic Ecosystem Health (Marine Waters)	Primary Contact Recreation	Secondary Contact Recreation	Parameter Exceeded
6	Upper Cooks River	Dry	H	NA	H	H	Nitrogen, F. Coliforms
6	Upper Cooks River	Wet	H	NA	H	H	
8	Upper Cooks River	Dry	H	NA	H	H	
8	Upper Cooks River	Wet	H	NA	H	H	
3	Upper Cooks River	Dry					
6	Central Cooks River	Dry	NA	H	H	H	Nitrogen, F. Coliforms
6	Central Cooks River	Wet	NA	H	H	H	Chlorophyll-a (Dryweather)
8	Central Cooks River	Dry	NA	H	H	H	
8	Central Cooks River	Wet	NA	H	H	H	
7	Cup & Saucer Creek	Dry	NA	H	H	H	Nitrogen, Phosphorus, F Coliforms
8	Cup & Saucer Creek (Lower)	Dry	NA	H	H	H	Nitrogen, F Coliforms
8	Cup & Saucer Creek (Lower)	Wet	NA	H	H	H	
8	Upper Wolli Creek	Dry	M	NA	H	H	F.Coliforms, Nitrogen
8	Bardwell Creek	Dry	M	NA	H	H	Ammonia, Nitrogen, F Coliforms
8	Bardwell Creek	Wet	M	NA	H	H	Ammonia, Nitrogen, F Coliforms
6	Lower Wolli Creek	Dry	NA	H	H	H	Nitrogen, F. Coliforms
6	Lower Wolli Creek	Wet	NA	H	H	H	Phosphorus (Wetweather)
8	Lower Wolli Creek	Dry	NA	H	H	H	Chlorophyll-a (Dryweather)
8	Lower Wolli Creek	Wet	NA	H	H	H	DO

Ref. No.	Sub-Catchment	Weather	Aquatic Ecosystem Health (Freshwater)	Aquatic Ecosystem Health (Marine Waters)	Primary Contact Recreation	Secondary Contact Recreation	Parameter Exceeded
6	Lower Cooks River	Dry	NA	H	H	H	Nitrogen, F. Coliforms
6	Lower Cooks River	Wet	NA	H	H	H	Phosphorus (Wetweather)
8	Lower Cooks River	Dry	NA	H	H	H	DO
8	Lower Cooks River	Wet	NA	H	H	H	Chlorophyll-a (Dryweather)
6	Alexandra Canal	Dry	NA	H	H	H	Nitrogen
6	Alexandra Canal	Wet	NA	H	H	H	Chlorophyll-a
8	Alexandra Canal	Dry	NA	H	H	H	F. Coliforms
8	Alexandra Canal	Wet	NA	H	H	H	
6	Muddy Creek	Dry	NA	M	H	H	F.Coliforms
6	Muddy Creek	Wet	NA	M	H	H	Nitrogen
8	Muddy Creek	Dry	NA	M	H	H	Phosphorus

L = Levels within guidelines

M = Low level of exceedance of guidelines

H = High level of exceedance of guidelines

NA = Not Applicable

Further monitoring was reported by Bankstown City Council (Bankstown City Council 1998) at two sites in the catchment (Rookwood Road and Como Road) in 1997 and 1998. The results indicate that water quality is generally in compliance with the guidelines, with the exception of a high proportion of sampling dates which exhibited high pH and several occasions when high levels of faecal coliforms and conductivity were measured. Toxic metals and other pollutants noted in the Ecosystem Health Report were not measured.

Coxs Creek

Only one monitoring point has been identified for this catchment in the Ecosystem Health Report to the Cooks River Catchment Management Committee (CRCMC 1996) in 1996. The site is in the lower reaches of the Creek and the results indicate poor to very poor compliance with unspecified guidelines for toxic substances such as copper, cadmium, lead, mercury and zinc; and for pesticides (chlordane, dieldrin and DDT). The unspecified guideline requirements were also exceeded for PCB's and high levels of oil and grease were noted.

Central Cooks River

This catchment represents the upper reaches of the tidal section of the river referred to as "not frequently used" in the Proposed Interim Environmental Objectives for NSW

Waters. It was extensively monitored in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board 1992b), with seven monitoring sites in this area. During dry weather these sites generally did not comply with Guideline levels for dissolved oxygen, nitrogen (NO_3), ammonia and chlorophyll-a. The concentrations of chlorophyll-a, generally for the total catchment, increased with distance from the highest being recorded in this sub-catchment. NFR levels are also high and levels of total phosphorous and filterable phosphorous are high indicating that the Guideline for PO_4-P will be exceeded. During the wet weather sampling high levels of turbidity, filterable and total phosphorous, total nitrogen and non-filterable residue results were noted. The levels of faecal coliforms also exceed the guidelines for both Primary and Secondary Contact Recreation during dry and wet weather sampling.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) included one sampling site in this catchment in 1996. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, cadmium, lead, mercury and zinc; and also with pesticides (chlordane, dieldrin and DDT) and PCB's. High levels of oil and grease were also noted.

The 1997 Environmental Indicators Report Monitoring Appendices (Sydney Water Corporation 1997) included one site in this catchment at Brighton Avenue with data from 1993 to 1997. The results indicate compliance with the Guidelines with the exception of filterable phosphorous, oxidised nitrogen, ammonia and chlorophyll-a in both dry and wet weather sampling. In dry weather the faecal coliform results indicate compliance with Secondary Contact Recreation Guidelines but not Primary Contact. However, wet weather results do not comply either guideline.

The Brighton Avenue site is also referenced in the Licensing Sewerage Overflows, Environmental Impact Statement for the Georges River and Southern Suburbs Geographic Area (Sydney Water Corporation 1998). This document also notes the failure of samples from this site to comply with guidelines for chlorophyll-a and with guidelines (SPCC,1990) for phosphorous and nitrogen.

Cup and Saucer Creek

This catchment was extensively monitored in 1990 and 1991 for the Cup and Saucer Creek Catchment Management Study (Water Board 1992a). From these results it can be seen that both the upper reaches (drain) and the lower reaches (part drain / part creek) of this catchment fail to comply with most of the required parameters in the Guidelines. Total phosphorous, total Kjeldahl nitrogen, zinc, iron, copper, chromium, lead and nickel exceed Guideline values throughout the catchment but are generally noticeably worse for the upper reach (drain) around the Kingsgrove Road and Trafalgar Street sampling sites. This is believed to be due to industrial activities in the area. Both NFR and BOD results are also high in this area. Toxic organics were found in the form of polycyclic aromatic hydrocarbons (PAH) and organochlorines (OC) in the lower reaches at Fore Street and Berna Street. Litter and sediment were also recorded as significant pollutants requiring the trash rack to be cleaned once per week.

In addition, in 1990 a further study was undertaken to review Water Quality in the Cooks River Catchment (Scientific Services 1991) which included two monitoring sites in the lower reaches of Cup and Saucer Creek. These results indicated high levels of turbidity even during dry weather sampling indicating pollution sources other than rainwater.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) in 1996 included one sampling site in this catchment at the upstream end of the lower reach. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, lead, mercury and zinc; and also with pesticides (chlordane, dieldrin and DDT). High levels of oil and grease were also noted.

Upper Wolli Creek

This catchment was included in the study undertaken to review Water Quality in the Cooks River Catchment (Scientific Services 1991) in 1990 with two monitoring sites in the upper reaches of the Upper Wolli Creek catchment. The results from this monitoring indicated high levels of pH, total phosphorous and faecal coliforms.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) in 1996 also included one sampling site in this catchment close to the junction with Bardwell Creek. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, lead and zinc; and also with the pesticide chlordane. High levels of oil and grease were also noted.

Bardwell Creek

The study undertaken to review Water Quality in the Cooks River Catchment (Scientific Services 1991) in 1990 included two monitoring sites on Bardwell Creek. The results from this monitoring indicated high levels of turbidity during dry weather sampling and very high levels of total nitrogen, ammonia, colour and faecal streptococci at the downstream site indicating a possible point source of pollution between the two sites.

Lower Wolli Creek

This catchment was monitored at three sites in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board 1992b). During dry weather these sites generally did not comply with guideline levels for dissolved oxygen, nitrogen (NO_3), ammonia and chlorophyll-a. NFR levels were also high and levels of total phosphorous and filterable phosphorous were high indicating that the guideline for PO_4-P would be exceeded. During the wet weather sampling high levels of turbidity, filterable and total phosphorous, ammonia and total nitrogen were observed. During dry weather sampling the levels of faecal coliforms were found to exceed the Primary Contact Recreation Guidelines at one site but comply with those for Secondary Contact at all sites. During wet weather sampling both Primary and Secondary Contact Guidelines were exceeded.

The Water Quality in the Cooks River Catchment Report (Water Board 1992b) in 1990 included one site at the upstream end of this catchment. The results from this site indicated a low level of dissolved oxygen at four milligrams per litre as the only concern, which was also noted in the 1992 Report above.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) in 1996 also included one sampling site in this catchment. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, cadmium, lead, mercury and zinc; and also with pesticides (chlordane, dieldrin and DDT) and PCB's. High levels of oil and grease and low levels of dissolved oxygen were also noted.

The 1997 Environmental Indicators Report Monitoring Appendices (Sydney Water Corporation 1997) included one site on this part of Wolli Creek downstream of the Bardwell Creek junction with data from 1993 to 1997. The results indicate general compliance with the Guidelines with the exception of dissolved oxygen (which appears to be decreasing over the last four years), filterable phosphorous, oxidised nitrogen and ammonia in both dry and wet weather sampling. In dry weather the faecal coliform results indicate compliance with both Primary and Secondary Contact Recreation Guidelines for most samples. However, wet weather results only comply with the Secondary Contact Guideline.

One site at Henderson Street was included in the Stormwater Monitoring Project, 1994 Annual Report (Sydney Water Corporation 1994) which noted that this site had the highest wet weather event mean concentration for total uncombined ammonia of all sites monitored in the Sydney catchments.

Marrickville/Sydenham Drainage System

No monitoring results have been identified specifically for this catchment. The Marrickville Council State of the Environment Report, 1997 (Marrickville Council 1997) refers only to regional data for the Cooks River and Alexandra Canal plus some sampling undertaken by local schools for the same areas. The report does however acknowledge that the condition of waterways in this area require significant Council policies and programs to improve the generally unsatisfactory conditions.

Lower Cooks River

This catchment was extensively monitored in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board 1992b), at fifteen sites spread evenly along this length of river. During dry weather these sites generally did not comply with Guideline levels for dissolved oxygen, nitrogen (NO_3), ammonia and chlorophyll-a. NFR levels were also found to be high and levels of total phosphorous and filterable phosphorous were higher than the guideline level. In general, the concentration of nitrogen, ammonia, phosphorous and chlorophyll-a for tis sub-catchment, as for the total catchment, tend to increase with distance upstream from the mouth of the River. During the wet weather sampling high levels of turbidity, filterable and total phosphorous, total nitrogen and non-filterable residue results were noted. During dry weather the levels of faecal coliforms exceed the Primary Contact Recreation Guidelines except for the first one kilometre at the river

mouth. The remainder were found to comply with the requirements for Secondary Contact Recreation. During wet weather the levels of faecal coliforms exceed both the Primary and Secondary Contact Recreation Guidelines.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee 1996) in 1996 also included one sampling site in this catchment. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, chromium, cadmium, lead, mercury and zinc; and also with pesticides (chlordane and DDT) and PCB's. High levels of oil and grease and low levels of dissolved oxygen were also noted.

The 1997 Environmental Indicators Report Monitoring Appendices (Sydney Water Corporation 1997) included one site on this part of the Cooks River downstream of the Muddy Creek junction with data from 1993 to 1997. The results indicate compliance with the Guidelines with the exception of filterable phosphorous, oxidised nitrogen and ammonia in both dry and wet weather sampling. In dry weather the faecal coliform results indicate compliance with both Primary and Secondary Contact Recreation Guidelines. However, wet weather results do not comply with either Recreation Guideline.

One site adjacent to Muddy Creek is also referenced in the Licensing Sewerage Overflows, Environmental Impact Statement for the Georges River and Southern Suburbs Geographic Area (Sydney Water Corporation 1998). This 1998 document also notes the failure of samples from this site to comply with guidelines for chlorophyll-a and with Guidelines (SPCC,1990) for phosphorous and nitrogen.

Sheas Creek

Very little monitoring has been identified in this upper reach of the creek as most previous work appears to have concentrated on the Alexandra Canal, which is the downstream section of this waterway. However, an extensive monitoring program of four sites in the catchment was undertaken in the Sheas Creek Stormwater Channel Water Quality Report (Simms, 1992). This study indicated that the samples taken did not comply with Guidelines for cadmium, copper, lead and zinc. In addition high levels of total phosphorous and nitrogen were found indicating that filterable phosphorous and oxidised nitrogen Guidelines are also likely to be exceeded. Suspended solids results were also high and average faecal coliform figures exceeded Secondary Contact Recreation requirements. Dry weather faecal coliform levels complied with Secondary Contact Guidelines only.

One site at Maddox Street was included in the Stormwater Monitoring Project, 1994 Annual Report (Sydney Water Corporation, 1994) which noted that Sheas Creek had the highest rainfall in the Sydney catchments monitored and the highest unit area exports for all pollutants. The high export (and run-off ratio) has been attributed to the extensive industrial use of groundwater in the catchment.

Alexandra Canal

This canal is the extension of Sheas Creek to the Cooks River. It was monitored in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks

River Report (Water Board, 1992b), at three sites in the lower half of the canal. During dry weather these sites generally did not comply with guideline levels for dissolved oxygen, nitrogen (NO_3), ammonia and chlorophyll-a. NFR and total phosphorous levels are also high. During the wet weather sampling high levels of turbidity, filterable and total phosphorous, oxidised and total nitrogen and non-filterable residue results were noted. During dry and wet weather the levels of faecal coliforms exceed the Primary and Secondary Contact Recreation Guidelines.

Monitoring reported in the Ecosystem Health Report to the Cooks River Catchment Management Committee (Cooks River Catchment Management Committee, 1996) in 1996 also included a number of sampling sites in this catchment. The results from this program indicated poor to very poor compliance with unspecified guidelines on toxic substances such as copper, chromium, cadmium, lead, mercury and zinc; and also with pesticides (chlordane and DDT mostly) and PCB's. High levels of oil and grease and low levels of dissolved oxygen were also noted.

Taking all parameters into account, this waterway is considered to have the poorest water quality in the Cooks River catchment.

Muddy Creek

The most extensive monitoring of this catchment was undertaken at three sites in early 1992 for the Dry and Wet Weather Intensive Water Quality Sampling Cooks River Report (Water Board, 1992b). During dry weather these sites generally did not comply with Guideline levels for dissolved oxygen, nitrogen (NO_3) and ammonia. Levels of total phosphorous and filterable phosphorous are high indicating that the Guideline for PO_4-P will be exceeded.

During the wet weather sampling high levels of turbidity, filterable and total phosphorous, ammonia and total nitrogen results were noted. During dry weather sampling the levels of faecal coliforms generally exceeded the Primary Contact Recreation Guidelines but complied with those for Secondary Contact. During wet weather sampling both Primary and Secondary Contact Guidelines are exceeded. Dry weather faecal coliforms results are considered to be impacted by an unidentified overflow/discharge event.

This catchment was included in the study undertaken to review Water Quality in the Cooks River Catchment (Scientific Services, 1991) in 1990 with one monitoring site in the creek catchment. The results from this monitoring indicated high levels of total nitrogen and ammonia, and faecal coliforms above Secondary Contact Recreation Guidelines.

Water Quality Hotspots

As detailed above, much of the catchment has extensive water pollution issues in terms of nutrients, eutrophication, metals, and faecal coliforms. However, the following areas are of significant concern for these and other factors:

- Georges River Road area of the Upper Cooks River Sub-Catchment (high BOD, possible unidentified discharge/overflow);

- Kingsgrove Road area of the Cup and Saucer Creek Sub-Catchment (high metal concentrations, possible industrial discharge);
- Sheas Creek Sub-Catchment (highest unit area export figures for pollutants for total Sydney Water catchment); and
- Alexandra Canal Sub-Catchment (poor performance on all parameters, particularly on copper, mercury, lead, zinc, oil and grease).

3.1.8 Sewer System

The nature and significance of discharges from the sewer system within the Cooks River Catchment was recently investigated by Sydney Water Corporation for the Sewer Overflow Licensing project (SWC, 1998). This study identified that the sewer system in the catchment is one of the oldest in Sydney and in poor condition, with leakage occurring from both privately owned and SWC owned pipes. Sandy soils and groundwater movement allow mitigation of discharged sewerage into the waterways.

Leaky pipes or connection of stormwater pipes to the sewer system can also allow rainwater to enter the system in wet weather, thus overloading it. If this occurs, or there are blockages or pump station failures, sewage can overflow at:

- *designed overflow points* – designated overflows are generally located at watercourses so that the overflowing sewage can be diluted, and the health risks reduced. Major overflows are considered to make up about 85 percent of total load;
- *non-designed overflow points* – the location of these are not always known or recorded, although SWC field staff are often aware of them;
- pumping stations which have provision for overflows; and
- "unintended overflows:, for example via access chamber covers. "Frequent surcharge locations" are recorded, but other locations are not always known or recorded.

The estimated significance of the pollution loads as a result of sewer system discharge are discussed in *Section 6.1*.

3.1.9 Groundwater Quality

The Botany Sands Aquifer in the lower Cooks River area is an important underground water resource from which water is pumped for use by industry, golf courses, and residents. The aquifer flows into Botany Bay and tributaries, including Alexandra Canal. There is significant contamination of parts of the aquifer as a result of past industry in the area (South Sydney Council, 1997). The large numbers of disused tip sites within the catchment are likely to be a significant source of contaminated leachate into the groundwater.

Water pumped from the aquifer is often later discharged to surface water and may contain chemical contaminants. In addition, the Alexandra Canal acts as a sump, with groundwater flowing to the ocean via the Canal. As a result, contamination of

the groundwater supply may be exacerbating the contamination of the waterways and sediments of the Cooks River. The Department of Land and Water Conservation is currently preparing a Groundwater Management Plan for the Botany Sands Aquifer.

3.1.10 Soil Erosion and Sedimentation

Soil Erosion

Wind erosion is the dominant agent of soil erosion in the eastern part of the catchment, particularly in the South Sydney and Botany Local Government Areas, where there are loose sandy soils. Sheet erosion presents a greater hazard to the north-west of the catchment, where the nature of the soils is more clayey. Water is the major agent of erosion inland, particularly in the Local Government Areas of Bankstown, Burwood and Strathfield (Soil Conservation Service 1991).

Existing erosion is confined to current development sites, rubbish tips and storage areas which present the greatest source of sediment. The long term point sources of sediment include the railway establishments at Chullora and Enfield which are proposed for redevelopment, Rookwood Cemetery and Jubilee Park (Rendell, undated). Areas where there are current erosion problems are identified in *Table 3.15*.

Table 3.15: Significant Erosion Sites Within the Cooks River Catchment

Location	Problem
Stormwater drain Eastern Boundary of Rookwood Cemetery	■ unprotected and eroding stormwater channel; and ■ lack or erosion & sediment controls on development immediately up stream of drain.
Chullora Railway Workshops	■ large areas of unvegetated material that is subject to water and wind erosion and is in close proximity to the river.
Enfield Marshalling Yards	■ as above.
Cooks River Goods Yard Sydenham	■ large areas used for container handling and storage; ■ Constant usage by heavy vehicles on exposed unprotected soil in close proximity to Alexandra Canal.
Wolli & Bardwell Creek	■ bank erosion occurs following even minor storm events.
Waste Transfer Station Alexandria and neighbouring tip sites.	■ large stockpiles of soil material with little, and in areas, no vegetation.
Eveleigh Railway Workshops	■ large areas unvegetated.
Cox's Creek Reserve	■ bank erosion occurs following even minor storm events.
Freshwater Park	■ bank erosion occurs following even minor storm events.

Reference: (Rendell, undated)

The Cooks River Catchment is almost completely urbanised, as a result the current sediment yield is considered to be relatively minimal. The estimate of current sediment yields from the catchment under present development conditions is assessed at 2.5 tonnes per hectare per year. Approximately 90-95 percent of this sediment will reach the tidal sections of the river, and as much as 80 percent of this sediment will

be carried in suspension (Rendell, undated). Greater rates of sediment erosion are expected during construction of major developments or roadworks in the catchment (Rendell, undated).

There are various structural sediment controls within the Cooks River Catchment as shown in *Table 3.16*. SSROC has recently prepared sediment control guidelines for construction activities throughout the catchment. However, at present soil conservation control measures are not uniformly specified throughout the catchment in conditions of development consent (Rendell, undated).

Table 3.16: Structural Sediment Controls

Authority	Sediment Control	Location
Rockdale Council	Silt Trap [56]	End of Spring St drain
Rockdale Council	Silt Trap [56]	Muddy Creek
South Sydney Council	Gully Pit Traps	Along roads in 80 percent of Council area

Sedimentation

Sediment particle size and hydraulic conditions will influence the amount of sediment that remains in the estuary. The coarser fraction is likely to be deposited in the upper tidal reaches and redistributed during very large events with outflow tidal conditions. The fine fraction will be progressively deposited. It is probable that a significant proportion will be totally removed from the estuary (Rendell, undated).

The main areas where heavy siltation have been noted are generally in the lower sections of Cooks River, particularly near the Boat Harbour and Marrickville Golf Course (Clouston 1997a). There is little information available on the sedimentation regime of the Cooks River tributaries. Alexandra Canal typically has little sediment transport, apart from high flow conditions during storm events (Hyder 1997).

Dredging occurs in some concrete line sections of the river where sediment accumulates and flooding is a problem, such as at Fifth Avenue, Campsie. The source of the sediments has been attributed to catchment erosion and channel bank erosion. In addition, some minor stream bank erosion occurs due to attrition from overland flow and fretting wave action (Total Environment Centre 1995).

Acid Sulfate Soils

Acid sulfate soils are the common name given to sediments and soils containing iron sulfides which, when exposed to oxygen generate sulfuric acid (ASSMAC, 1998). Maps produced by the Soil Conservation Service of NSW and DLWC, indicate that acid sulfate soil conditions existing in bottom sediments of all the tidally influenced areas of the Cooks River. The areas immediately south of the lower Cooks River are also considered to support acid sulphate soils , 1-3 metres below ground surface. Any removal of surface water, or lowering of the watertable, that protects potentially acid sulphate soils, will result in their aeration and the exposure of iron sulfides to oxygen. Acid sulphate soils present severe environmental risk if disturbed by activities such as dredging, excavation, or clearing. The potential for acid sulphate soils needs to be considered for all stormwater management activities that involve exposure of bottom sediments to oxygen.

3.1.11 Sediment Quality

Contaminated sediments pose a major problem for environmental management of the Cooks River catchment. Past land use and pollutant management practices in the catchment have resulted in high levels of contamination of sediments within the channel and in surrounding lands. Profiles of sediment quality in the channel close to the mouth of the Cooks River indicate that contamination levels are higher beneath the more recently deposited surface layers. Elevated levels of chemicals have been recorded in sediments up to nine metres below the surface (Hyder 1997). Whilst sediments are immobilised they do not pose a significant threat to water quality. However, if the surface layers are dredged or moved via naturally transportation, contaminants may be released into the water column.

The major ongoing sources for contamination of channel sediments are most likely to include:

- road run-off;
- urban run-off;
- atmospheric fallout;
- general litter;
- construction run-off;
- stormwater run-off from industrial areas; and
- waste material discharged from past and current industrial and commercial premises.

The rates of natural biodegradation of chemical contaminants are slow, due to low oxygen availability in the sediments. This is particularly the case for chemicals with more complex structures such as polychlorinated biphenyls and organochlorine pesticides which have been identified in Alexandra Canal (Hyder 1997). Locations of major industrial areas, likely to result in past contamination of sediments in the waterways include:

- the Rockdale section of Muddy Creek;
- the Turrella section of Wolli Creek;
- the Kingsgrove section of Wolli Creek;
- the Belmore section of Cup and Saucer Creek; and
- the Enfield Marshalling Yards and Chullora Railway Workshops.

Sites where major roads cross the waterways, or where road drainage outlets discharge to waterways are potential contamination sources as a result of stormwater run-off from roads exposed to heavy motor vehicle usage. Major road crossings include:

- Marsh Street;
- General Holmes Drive;

- Canal Road;
- Bayview Avenue;
- Bexley Road;
- Bardwell Road;
- Canterbury Road;
- Brighton Avenue; and
- Illawarra Road.

During the past twenty years, contamination from industry has decreased dramatically and pollutant management practices have reduced non-point source pollution. As such, the waterways have shown a gradual improvement in sediment quality.

3.2 Biological Environment

3.2.1 Aquatic Flora and Fauna

The aquatic systems of the Cooks River have been significantly modified and polluted since European settlement. The tidal sections of the Cooks River were described in the 1800's as being surrounded by saltwater swamps and mudflats bordered by mangroves and saltmarshes.

The following changes to this original ecosystem have resulted in a River system that has little value as aquatic habitat:

- concrete lining of the river bed along most sections of the river system;
- filling in of intertidal zone and mudflats and removal of mangrove forests;
- sealing of bank habitats with steep constructed river walls;
- clearing of riparian and floodplain vegetation;
- diversion of creeklines and piping of natural drainage lines;
- changes in flow regimes particularly wet weather flow velocities; and
- point and non-point pollution discharges.

Studies of fish and macroinvertebrate communities within the Cooks River indicate a limited diversity of aquatic species. Species recorded are dominated by polychaetes and molluscs known to be tolerant to highly contaminated river systems. Fish species found in the river include mullet, eel and galaxies and gobies (Sydney Water, 1998). The limited diversity of aquatic fauna is characteristic of a polluted waterway.

The species diversity is greatest within the tidally influenced sections of the River and rapidly declines with distance upstream (Total Environment Centre, 1976). Aquatic fauna surveys (Total Environment Centre, 1976) indicate that the mouth of the river

and its lower reaches have a much greater species diversity than habitats further upstream (Total Environment Centre, 1976).

Prior to European settlement, the fish and shellfish caught in the Cooks River supported local aboriginal communities (Total Environment Centre, 1995). Today, all forms of commercial fishing are banned in the Cooks River due to toxicants which accumulate within the fish and represent a health risk to consumers. A technical report by the Central Sydney Area Health Service (1997) concluded that the taking of fish, shellfish and crustaceans from the Cooks River should be banned for both recreational and commercial operators. Currently, under the *Fisheries Management Act, 1994* it is still permissible for recreational fishers to catch fish by the use of rod or handline (Central Sydney Area Health Unit, 1997).

The poor water quality of the Cooks River has often resulted in acute toxic effects on fish within the River. During summer, 1997, the release of the pesticide, chloropyrifos into the drainage system of the Cooks River resulting in an acute toxic spike that killed thousands of fish and over 100 birds. This event followed the fish kill that occurred during October, 1991 where thousands of fish were found dead. This time, whilst a pollutant was not specifically identified, the waters displayed very low dissolved oxygen levels.

3.2.2 Wetlands

- The Cooks River catchment contains a number of wetlands that are considered to be regionally significant owing to their limited distribution and their fragmented status. These wetlands offer locally valuable habitat for native fauna including birds, mammals, fish, reptiles, amphibians, insects and other invertebrates. The major wetlands within the Cooks River Catchment are described below and their locations illustrated in Figure 7.

Rockdale Wetlands

The Rockdale Wetlands consists of three wetland systems contained within three distinct catchments including: Cooks River, Botany Bay and Georges River. The Rockdale Wetlands corridor is connected to Botany Bay by a 700 metre underground channel which allows tidal exchange and a modified access route for fish and invertebrates. The Rockdale Wetlands system has been recognised regionally for its scenic, ecological, recreational and heritage significance (Rockdale City Council, 1995). It also acts as a floodway during major rainfall events.

- The Cooks River component is tidal and runs from the confluence of the Cooks River and Muddy Creek down to Bestic Street. The Cooks River component includes the Cooks River headwater, Kyeemagh Canal boat harbour, Muddy Creek Canal, Eve street ponds and the Landing Light Wetland (located to the South of Barton Park).

The wetlands system offers significant habitat for native Australian wetland birds and a refuge and temporary feeding ground for a number of migratory birds. The threatened bird species and species protected by the Australia Migratory Birds Agreements (CAMBA and JAMBA) which occur in these wetlands are listed in *Table 3.17*. In addition, the wetlands are utilised by a number of terrestrial fauna species including

bandicoots, common Brushtail possums, water rats, small skinks and various species of frogs. A number of introduced species including: black rat, house mouse, cats, dogs, and rabbits.

Weed growth in the wetlands include the following species; water hyacinth, umbrella sedge, Indian canna, lantana, Ludwigia, honeysuckle, bramble and kikuyu (Rockdale City Council, 1995). These species are out-competing native species and effecting the water quality of the wetlands.

Table 3.17: Significant Bird Species recorded in Rockdale Wetlands

Common Name	Scientific Name
Birds listed on the China-Australia Migratory Bird Agreement (CAMBA,1986)	
Caspian Tern	*Hydropogne tschegrava*
Curlew Sandpiper	*Calidris ferruginea*
Great Egret	*Egretta alba*
Greenshank	*Tringa nebularia*
Latham's Snipe	*Capella hardwickii*
Lesser Golden Plover	*Pluvialis dominica*
Little Tern	*Sterna albifrons*
Red-necked Stint	*Calidris ruficollis*
Sharp-tailed Sandpiper	*Calidris acuminata*
White-winged Tern	*Chlidonias leucoptera*
Birds listed on the Japan-Australia Migratory Bird Agreement (JAMBA, 1974)	
Common Tern	*Sterna hirundo*
Curlew Sandpiper	*Calidris ferruginea*
Greenshank	*Tringa nebularia*
Little Tern	*Sterna albifrons*
Pectoral Sandpiper	*Calidris melanotos*
Red-necked Stint	*Calidris ruficollis*
Sharp-tailed Sandpiper	*Calidris acuminata*
White-winged Tern	*Chlidonias leucoptera*
Threatened Species Conservation Act, 1995	
Vulnerable	
Comb-crested Jacana	*Irediparra gallinacea*
Endangered	
Little Tern Endangered	*Sterna albifrons*

Eve Street Wetlands

The Eve Street Wetlands are a remnant of the larger Barton Park wetland system which once stretched from Eve Street to the Cooks River. Much of the original wetland was lost by landfill operations to create playing fields and parkland. In 1993, Sydney Water in association with the local community, began restoration works on a section now known as the Eve Street Wetlands in Arncliffe. This wetland now provides important refuge and feeding grounds for migratory birds and is considered of regional ecological value (Rockdale City Council, 1995). The ecological values of the

Eve Street wetlands, as a component of the Rockdale wetlands, are recognised by its listing on the Commonwealth Directory of Important Wetlands.

Wolli Creek Wetlands

A number of wetlands providing both estuarine and fresh aquatic habitats occur within Wolli Creek and its tributary, Bardwell Creek as illustrated in Figure 6. Turrella weir marks the division between estuarine and freshwater conditions (Manidis Roberts, 1994). The estuarine wetlands of Wolli Creek cover an area of 1.5 hectares and support three major herbland communities:

- Austral Seablite (*Suaeda australis*) and Common Reed;
- Beaded Glasswort (*Sarcocornia quinqueflora*) and Common Reed; and
- Beaded Glasswort and Streaky Arrow-Grass (*Triglochin striata*).

Mangrove forests dominated by the Grey Mangrove (*Avicennia marina*) occur along 2.5 kilometres of foreshore in Wolli Creek (Figure 7). The freshwater wetlands above Turrella weir are generally in poor condition, with condition and species diversity improving with distance upstream. The predominant freshwater wetland species include Common Reed, Tall Spikerush (*Eleocharis sphacelata*) and Cumbungi (*Typha* sp.) (Manidis Roberts, 1994).

The Wolli Creek wetlands provide habitat for more that 160 bird species which are either permanent residents or migratory visitors to the area. The estuarine wetlands have been identified by the Ecology Lab (1995) as providing critical nursery habitat for a number of commercially important fish and prawns.

Other Cooks River Wetlands

A waterhole adjacent to the Cooks River off Dibble Avenue, Dulwich Hill, has formed in what was formerly the Toyer Brothers brick pit. The waterhole has been used for many years as a haven for several wetland bird species (Total Environment Centre, 1995).

Mangroves

Mangroves have been re-established along sections of the Cooks River and Muddy Creek, particularly in the vicinity of Steel and Kendrick Parks. Mangroves have been planted by Marrickville Council around Fatima Island. Although there are no large areas of remnant indigenous vegetation in the Marrickville Council area, a number of trees along the Cooks River including mangroves, and fig and palm trees, have been recorded as significant in the Marrickville Heritage Study (Marrickville Council, 1994: Total Environment Centre, 1995).

The success of natural re-colonisation of mangroves in Wolli Creek has been well documented. The original low closed forest mangroves of Wolli Creek were considered non-existent following the construction of the Tempe Dam in 1840 which deprived the mangroves of tidal salt water essential for their survival. In 1970, six years after the Dam was removed the first evidence of a re-colonising mangrove

community occurred. The area of mangrove has increased rapidly over the last twenty years and is likely to continue to expand its range (Brown *et al*., 1988a). At present around 0.024 square kilometres of mangroves now cover Wolli Creek's tidal plain adjacent to Bayview avenue, Turrella. A study of macro invertebrate fauna of the Wolli Creek conducted by Brown *et. al*. (1988b), found the number of arthropod species to be far greater than that reported ten years earlier in 1978.

From 1994 to 1996 a restoration and rehabilitation program was carried out along the western shoreline of Muddy Creek. This involved the planting of grey mangrove seedlings to regenerate the shoreline ecosystems and to support the mature mangroves growing naturally along the eastern shoreline (Kinhill Engineers, 1993).

Wetlands are vulnerable to the impacts of poor stormwater quality with major threats presented by:

- disposal of litter and other solid wastes;
- discharge of residential and industrial effluent, stormwater and run-off leading to pollution;
- oil and chemical spills;
- increasing suspended solids;
- reclamation and modification of land for commercial, residential and infrastructure developments; and
- construction of harbours and engineering structures such as channelisation of river and creek channels (Manidis Roberts, 1994).

3.2.3 Riparian and Foreshore Flora and Fauna

The native flora and fauna of the Cooks River valley survive in small remnants of the original vegetation which occur primarily in open space and parkland areas along the River foreshores. The remaining bushland and foreshore vegetation remnants are considered of high ecological value and important for conservation of biodiversity within the region (Total Environment Centre, 1995b). The remnant bushland areas of the Cooks River are illustrated in *Figure 7* and described below.

Cooks River Plain Scrub Forest Remnants

A remnant of the original clay-soil bushland which was once widespread throughout the Cooks River catchment remains along Freshwater Creek within the Chullora Railway Yards. This remnant vegetation, known as the Cooks River Clay Plain Scrub Forest, is classified as an endangered ecological community and protected by the *NSW Threatened Species Conservation Act, 1995*. The Bankstown Bushland Society have been enhancing the value of this three hectare remnant through a bush regeneration program. The site is owned by the National Rail and is part of a recent proposal for redevelopment.

A site at the end of Third Avenue, Campsie, also supports an isolated small remnant of Cooks River Clay Plain Scrub Forest. The site occupies about 0.5 hectares between the Cooks River and its junction with a small stormwater canal (Total Environment

Centre, 1995b). The vegetation has patches of scrub, native grassland and mature trees. This remnant is relatively undisturbed as the natural Wianamatta Shale soils are largely unmodified and, due to the topography of the site, have not been impacted by high nutrient run-off. The remnant vegetation at this site has scientific and natural heritage significance (Total Environment Centre, 1995b).

A third remnant of this endangered ecological community, known as Freshwater Park, is located along the foreshores of the Cooks River at Hedges Avenue, close to Strathfield High School.

Cox's Creek Reserve, at Sylvans Street, Greenacre, is a significant remnant of the Cooks River Clay Plain Scrub Forest covering an area of 1.65 hectares. The remnant is managed by Strathfield Council and bush regeneration works have been undertaken with the assistance of volunteers since 1996. The site supports a well preserved example of Melaleuca Scrub and provides habitat for the threatened Green and Golden Bell Frog, *Litoria aurea.* The reserve is dissected by two earth bank stormwater channels which are known to erode in high rainfall events.

Wolli Creek Remnants

The Wolli Creek valley supports a diversity of natural environments including mangroves, heaths, eucalypt forests, wetlands and a pocket of coachwood-watergum rainforest (Total Environment Centre 1995b). The condition of vegetation throughout the valley varies with both healthy bushland remnants and significantly degraded areas. In recent years efforts by local Councils, residents groups, and the National Trust have assisted with the protection and enhancement of this area. The number of bird species found in the area has increased over the last twenty years with current estimates of over 160 bird species (Total Environment Centre 1995b). Water birds include migratory bird species that have travelled from Japan and Siberia and are protected through international treaties (Total Environment Centre, 1995b).

Foreshore vegetation along Wolli Creek extends from Bexley Road, Earlwood, through to Waterworth Park, Undercliffe, and includes the popular Girrahween Park. Vegetation along Bardwell Creek extends from Preddys Road, Bexley to its confluence with Wolli Creek near Edith Street, Bardwell Park. Small remnants of bushland survive along Wolli and Bardwell Creeks.

The upper Bardwell Creek valley supports patches of open woodland of Sydney Red Gum (*Angophora costata*) and Sydney Peppermint (Eucalyptus piperita) with a diverse shrubby understorey supporting 80 different species (Benson and Howell, 1990). Remnant woodland vegetation can be seen along Wolli Creek at Girrahween Park and Nanny goat Hill at Earlwood. Shrubby heath can be seen at Highcliffe Road, Undercliffe (Benson and Howell, 1990; Total Environment Centre, 1995b).

Shrubland vegetation occurs between Bexley Road and the Bardwell Valley Golf Course with the predominant species being Tick Bush (*Kunzea ambigua*), Black She-Oak (*Casuarina littoralis*), NSW Coral Heath (*Epacris pulchella*), Fuchsia Heath (*Epacris longiflora*), Coral Heath (*Epacris microphylla*), *Astroloma pinifolium* and *Styphelia tubiflora*. This vegetation is found on a quarry site where bared rock has allowed the heath species, which are now rare in this part of Sydney, to prosper.

A rare remnant of Sydney Blue Gum (*Eucalyptus saligna*) open forest occurs along a small tributary within Stotts Reserve at Bexley North. Sydney Redgum - Sydney Peppermint (*Angophora costata - Eucalyptus piperita*) woodland association also occurs in within this area (Benson and Howell, 1990; Total Environment Centre, 1995b).

National Parks and Wildlife Service identified a diversity of vegetation types along Wolli Creek following a detailed study in 1988. The vegetation communities observed following a field survey and review of existing literature are identified in *Table 3.18*. Whilst a diversity of vegetation types were recorded, the extent of each community was limited (Total Environment Centre, 1995b).

Table 3.18: Vegetation Survey of Wolli Creek

Location Along Wolli Creek	Vegetation Structural Type	Dominant Species of Vegetation Associations Common Name (Scientific Name)
Bexley North, on north side of Wolli Creek	Low Closed Forest	Coachwood-Water Gum (*Ceratopetalum apetalum - Tristaniopsis laurina*)
Tidally influenced parts of the lower Wolli Creek	Low Closed Forest	Grey Mangrove - River Mangrove (*Avicennia marina - Aegiceras corniculatum*)
Sheltered hills and gullies	Forest	Blackbutt-Sydney Peppermint - Sydney Red Gum (*E. Pilularis - E piperita - Angophora costata*)
Freshwater wetland, lower Wolli Creek	Low Forest	Paperbark species (*Melaleuca spp*.)
South facing hillsides	Open Forest	Sydney Red Gum - Red Bloodwood - Sydney Peppermint *Angophora costata - Eucalyptus gummifera - e. Piperita*)
South facing hillsides	Low Open Forest	Sydney Red Gum - Turpentine – Bangalay (*A. Costata - Syncarpia glomulifera - E. botryoides*)
Ridges, plateaux and dry exposed hillsides	Forest	Red Bloodwood – Blakely (*E. Gummifera - E. sclerophylla*)
Rocky outcrops	Scrub	Tick Bush (*Kunzea ambigua*)
Moist sites along lower Wolli Creek	Grassland	Common Reed (*Phragmites australis*)
Saltmarsh areas, lower Wolli Creek	Sedgeland	Sea Rush (*Juncus krausii*)
Saltmarsh areas, lower Wolli Creek	Herbland	Austral Seablite - Common Reed (*Suaeda australia - Phragmites australis*)
		Samphire - Common Reed (*Sarcocornia quinqueflora - Phragmites australis*)
		Samphire – Street Arrow-grass (*S. Quinqueflora - Triglochin striata*)

(Source: Total Environment Centre, 1995b)

At Marrickville the Cooks River follows a narrow valley with steep Hawkesbury Sandstone slopes. Prior to European settlement, Blackbutt (*Eucalyptus pilularis*) forest with a typically sclerophyllous understorey of shrubs predominated in this area.

There are still some remaining Blackbutts in Marrickville Golf Course. Swamp Oak (*Casuarina glauca*) forest was also common along the River, with mature trees occurring in Marrickville Golf Course, as well as many younger plantings (Benson and Howell, 1990; Total Environment Centre, 1995b).

Weeds

One of the major impacts on the riparian vegetation of the Cooks River Catchment is the spread of exotic species. Weeds are encouraged by poor water quality which provides sediment deposits on which they may establish and high nutrient concentrations. The major weed species within the catchment include (Bankstown City Council, 1997):

- Noxious Weeds - terrestrial noxious weeds which are prevalent in Bankstown are Blackberry, Castor Oil, Green Cestrum, and Lantana, which are spread across Bankstown. The remaining terrestrial noxious weeds include Pampas Grass, Prickly Pear, Pellitory of the Wall and Rhus Tree which are limited in area, on private and Council land. There are however serious infestations of Pampas Grass on State Government Land at Chullora and Yagoona (Bankstown City Council 1997); and
- Other Weeds - The major environmental weeds impacting on bushland areas have been identified as Asparagus Fern, African Love Grass, African Olive, buffalo Grass, Bridal Creeper, Canna Lily, Cape Ivy, Carpet Grass, Cobblers Peg, Couch, Crofton Weed, Fennel, Honeysuckle, *Juncus acutus*, Kalanchloe, Kikuyu, Madiera Vine, Morning Glory, Moth Vine, Ochna, Paddys Lucerne, Pigeon Grass, Purple Top, Small-leaved privet, Turkey Rhubarb, Wandering Jew.

These weeds typically outcompete native species, and degrade the ecological values of wetlands, remnant bushland and riparian zones.

Terrestrial Fauna

Terrestrial fauna species in the Cooks River catchment are considered to be typical of most Sydney urban catchments. Pressures on native fauna and their habitats as a result of land clearing, intense development, recreation use, introduced fauna, pollution, draining and filling of wetlands, and fluctuating fire regimes have greatly reduced species diversity (Clouston, 1997a).

Terrestrial fauna species that use the Cooks River catchment as habitat include a variety of birds (such as Superb Fairy-wrens and New Holland Honeyeaters), Grey-headed Flying-Fox, Common Brushtail Possums, the Bush Rat, bats, lizards (such as the Common Blue Tongue) and frogs (such as the Striped Marsh Frog, the Common Foglet and the Green and Golden Bell Frog).

The Green and Golden Bell Frog is a species of state significance being listed as 'endangered' pursuant to the *Threatened Species Conservation Act (1995)*. The Green and Golden Bell Frog has been found at the Enfield Marshalling Yards, Coxs Creek Reserve, Brickpits on Punchbowl Road, Eve Street Wetlands, and the Rockdale Wetlands.

4. Catchment Values

The identification of catchment values for the Cooks River has been the subject of numerous studies and recent community surveys undertaken by Councils, Sydney Water, the Catchment Management Committee, and the Total Environment Centre. Based on this existing information, and on the outcomes of the community and stakeholder consultation undertaken as part of this study. The values of the Cooks River, have been identified, relevant to stormwater management.

4.1 Consultation Process

The community were consulted about their vision for the Cooks River catchment and key stakeholders asked to identify catchment values, stormwater issues, hotspots, causes and options for stormwater management. The community of the Cooks River is diverse, consisting of 400,000 residents and 100,000 commercial and industrial businesses. A number of strategies were used to consult the community, including a questionnaire, briefing paper, community workshop, media release, posters, school newsletters and a letter box drop.

Briefing Paper & Questionnaire

A questionnaire and briefing paper (*Appendix A*) were mailed to over 200 local interest groups, residents, businesses, industries, and local Councillors. Over 300 copies of the questionnaire were also distributed to the local Councils, Total Environment Centre and Catchment Management Committee. The briefing paper provided information on the project and invited interested members of the community to participate in the community workshops.

A total of 75 responses to the questionnaires were received. Many responses indicated a strong interest in preventing pollution of stormwater and improving the water quality of the Cooks River. A diverse range of groups responded, including local environment groups, residents, bicycle and rowing clubs and peraters of commercial premises. Respondents provided views on stormwater management, the condition of the River, sources of pollution, and made suggestions for cleaning up stormwater and improving local waterways. The response to the questionnaire is summarised below and the statistical analysis is provided in *Appendix A*.

Perceived Condition of the Waterways in the Cooks River Catchment.

Question C asked members of the community how they perceived the condition of the waterways in the Cooks River catchment. The majority of respondents (61 percent) considered the Cooks River to be no longer a river, but rather an urban drain. Other respondents considered the Cooks River to be a degraded environment with few values (18 percent), while only 10 percent of respondents considered the River to be in reasonable condition with need for improvement in some areas. There were no responses in relation to the river being in good condition with no need for improvement and 11 percent of respondents had no opinion on the condition of the river.

Objectives for the Cooks River

Question B aimed to determine the preferred uses of the Cooks River so as to identify objectives relating to the recreational, ecological, and economic goals.

The protection of aquatic flora and fauna within the Cooks River catchment was the primary objective of the majority of respondents. Most respondents considered visually pleasing waterways suitable for swimming to be the next most important objective. The waterways being suitable for boating, canoeing, swimming, playing and other recreation along the banks was considered the third most important objective, with commercial fishing the least important objective.

Catchment Issues

Question A was designed to determine what was important to the community in terms of the use and condition of the waterways in the catchment. Responses were perceived to be values the community places on the waterways, defined in terms of environmental, health and recreational values.

Most people considered poor water quality and rubbish in the waterways to be the biggest environmental concern for the catchment. Lack of natural features, lack of water plants and animals due to changes to habitat, removal of plants along the river banks and murky/muddy waterways were all considered equally the next most important concern.

Most people considered poor management and inadequate funding of stormwater management closely followed by health risks associated with the recreational use of polluted water the biggest health and recreational concerns for the catchment. Poor visual appearance of the stormwater creeks and channels and the health risks of eating fish and shellfish caught in the river were also reported to be important health and recreational issues. Lack of sporting parks, open space and recreational facilities along the waterways and lastly, loss of economic values due to water pollution (such as decreased property values) were considered the least important health and recreational values for the catchment.

Stormwater Pollution Causes

Question D aimed to evaluate community perception of the likely sources of stormwater pollution.

Runoff and contamination from commercial and industrial areas and sewer overflows, (including illegal connections and leaks from the sewerage system) were perceived to be the most important causes of stormwater pollution. This was closely followed by litter entering the stormwater system and dumping of rubbish into waterways and chemicals from old waste landfills and contaminated sites leaking into the waterways. The next most important causes of stormwater pollution were perceived to be stormwater run-off from roads, railways and airport facilities, then stormwater run-off and sediment from construction activities, and lastly stormwater run-off from residential areas.

A number of additional comments were provided by some respondents in relation to the questions answered. These included views on the planning process, identification of past studies, provision of information on specific causes of pollution locally, and suggested actions for preventing pollution of stormwater. These comments have been listed in *Appendix B* and incorporated in the formulation of options for treating and preventing pollution of stormwater.

Community Workshops

Three community workshops were held to discuss values and objectives for the catchment and to identify issues effecting stormwater quality. The workshops were held on the following dates:

- 6.30pm Thursday, 19 November at Strathfield Community Centre;
- 10.30am Saturday, 21 November at Petersham Town Hall; and
- 6.30pm Monday 23 November at St Georges Rowing Club.

More that 60 community stakeholders participated in these workshops identifying catchment values, management objectives and stormwater pollution hotspots. A complete list of the representatives from local environment and community groups, local businesses and residents who have been involved in the development of this Plan are identified in *Appendix C*.

Informing the Community

The community within the Cooks River catchment were informed of the development of the Stormwater Management Plan through media, letterbox drops and public displays.

Six local newspapers ran stories on the preparation of the Stormwater Management Plan for the Cooks River, including one ethnic community newspaper, El Telegraph. Some of the articles published are included in *Appendix D*. The thirteen Councils within the catchment each published workshop dates and details of the Plan in the Council column of their local community paper.

Posters advising of the project and inviting community involvement were displayed at Council offices and the Cooks River Catchment Management Committee office, as well as at libraries and notice boards throughout the catchment.

A large number of primary and secondary schools are located within the Cooks River catchment. District education officers were interested in involving school children in the development of solutions to stormwater pollution. Details of workshop dates and the preparation of the Stormwater Management Plan was forwarded by the District Office to all schools for inclusion in the schools Weekly Newsletter.

A letter box drop of information sheets, targeted 1,500 residences, commercial and industrial properties along lower reaches of Wolli Creek and the Cooks River. The information sheets were designed to generate interest in the project and invite community involvement from those most likely to benefit from improvements in the Cooks River.

It is anticipated that these community groups will continue to be informed of progress with the Stormwater Management Plan and will be invited to be involved in its implementation.

Public Exhibition

The community provided further input to the development of the Cooks River Stormwater Management Plan at the Cooks River Festival and during a launch of the Draft Plan. The display of the draft document enabled the community to discuss stormwater issues and management options with Council representatives.

The Draft Plan was on public exhibition during March and April, 1999, at all 13 Council offices and at the Cooks River Catchment Management Committee office. Formal submissions on the Draft Plan were received from:

- Mr Atkin;
- Rockdale Wetlands Society;
- Bankstown Council;
- Auburn Council;
- Botany Bay Council;
- Rockdale Council;
- South Sydney Council;
- Randwick Council;
- Ashfield Council;
- Strathfield Council;
- Hurstville Council;
- Marrickville Council;
- Canterbury Council;
- Environment Protection Authority;
- Sydney Water Corporation; and
- South Sydney Development Corporation.

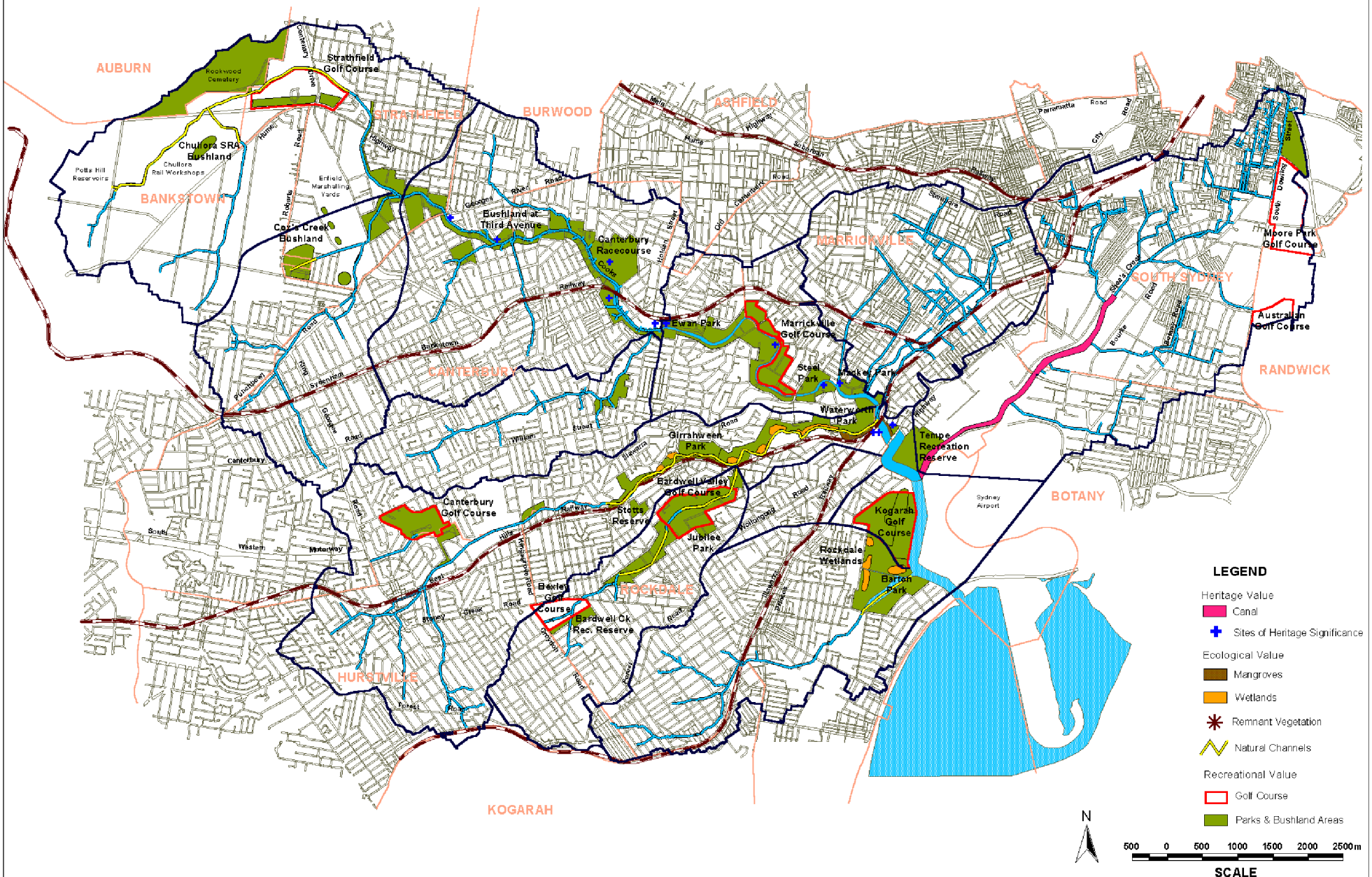
In many cases, the issues raised in these submissions provided further detailed information which issues included in the Final Stormwater Management Plan.

Incorporating the Outcomes

The residents and community groups within the Cooks River catchment have experienced the Cooks River in many states, some with memories of pollution problems and modifications to the River spanning 25 years. This wealth of knowledge gained from the community consultation process, enabled identification of

Figure 6

Cook River Catchment Values



the community's values and objectives for the Cooks River, and provided the basis for the development of actions for stormwater management.

4.2 Values of the Cooks River

The key values of the Cooks River, as identified through the consultation process, include ecological, recreational, amenity, health and economic values.

4.2.1 Ecological Values

The natural aquatic habitats of the Cooks River have been significantly modified, such that the river now provides only limited habitat for aquatic and riparian species. The aquatic habitats of ecological value that remain along the Cooks River are illustrated in *Figure 6* and include:

- areas of natural creekline in the lower section of Wolli and Bardwell Creeks and the upper reaches of the Cooks River, where the natural bed and channel of the river has not been modified with concrete lining or steel piling;
- areas of remnant mangrove forest and wetlands in the tidal sections of the River which provide habitat for waterbirds and aquatic species; and
- areas along Muddy Creek where recent plantings of mangrove stands has been successful and aquatic species are recolonising.

The natural terrestrial habitats within the Cooks River catchment are even more limited with only areas such as parklands and golf courses containing remnants of the original vegetation of the area. The terrestrial and riparian habitats of ecological value are also illustrated in *Figure 6* and include:

- areas of the remnant endangered Cooks River Clay Plain Scrub; and
- areas of remnant riparian vegetation along Wolli Creek, including patches of open forest, scrub, grass and sedgelands.

The ecological values of these remnant riparian habitats are being improved through bush restoration works.

4.2.2 Social Values

The social values identified for the Cooks River include heritage, recreational and aesthetic values. The heritage and cultural significance of the Cooks River has been assessed in a number of reports and there are many heritage sites protected by Council Local Environment Plans.

Aboriginal occupancy of the Cooks River area is known from a number of finds including middens (large numbers of discarded shells), two stone axes, and remains of a dugong. Marks on the dugong bones indicate the presence of Aborigines in the area at least 7000 years ago (Hyder 1997). The Darug people claim traditional ownership and consider the Cooks River to have been of value to the Aboriginal

people as a food providing ecosystem. In its current state, however, Aboriginal people see the Cooks River as a waterway of low value as it can no longer be used for drinking, fishing, swimming, camping, or hunting. The Aboriginal heritage values of the Cooks River which remain include an open camp site and two midden sites, which are identified on the National Parks and Wildlife Service register.

The Cooks River flows through the first European settlement and the oldest industrial area in Australia. The Alexandra Canal has been assessed as having historic, technological, scientific and aesthetic significance in a detailed report undertaken by Sydney Water (Casey & Low Associates 1993). The Canal is a rare example of canal construction and its sandstone pitched walls, characteristic of the nineteenth century, were built by unemployed relief workers.

Key items of heritage value along the foreshore of the Cooks River (illustrated in *Figure 6*) from Botany Bay west are:

- concrete block embankments built in the 1930's as depression relief work;
- Tempe House built in 1836 and listed by the Australian Heritage Commission on the Register of National Estate;
- Kendrick Park middens, discarded oyster and other crustacean shell used by the Aboriginal people;
- Warren Mansion remains are the stone pillars at Richard's Lookout;
- Sewer Aqueduct at Marrickville was built in the early 1880s;
- Marrickville Golf Course previously known as Riverside Park, was a favourite picnic spot around the 1900's;
- ASC Sugar Mill built in 1841 is listed on the Register of National Estate;
- Row of Canary Island Palms at Tasker Park;
- Canterbury Racecourse operating since 1871;
- Memorial Fountain at Ford Park constructed in the 1930s; and
- St Ann's Church (Clouston 1997).

The Cooks River is also valued by the community for its recreational potential. As illustrated in *Figure 6*, the parklands along the Cooks River provide an almost continuous green corridor. These foreshore parks and golf courses provide a visually pleasing environment and offer recreational opportunities for residents and visitors to the area.

The estuarine waterways are utilised for boating but are unsafe for swimming, and on occasions, unsafe for secondary contact recreation. Residents noted the potential to improve visual amenity, and in particular improve unsightly sections of the stormwater system so water views can be enjoyed by residents.

In its current state, the Cooks River is unsafe for swimming, consuming fish caught in the River, and at times, boating. In addition, the steel piling walls in some sections of the River make it difficult to climb out of the waterway.

4.2.3 Economic Values

The Cooks River is considered to have low economic value in its current state as commercial fishing within the river is prohibited and the water quality is unsuitable for aquaculture. Residents noted that the scenic value of the River is low in many areas and could be improved to assist property values.

Groundwater is still used as cooling water by a few industrial premises within the catchment but there is currently limited onsite detention and reuse of stormwater.

4.2.4 Assessment of Values

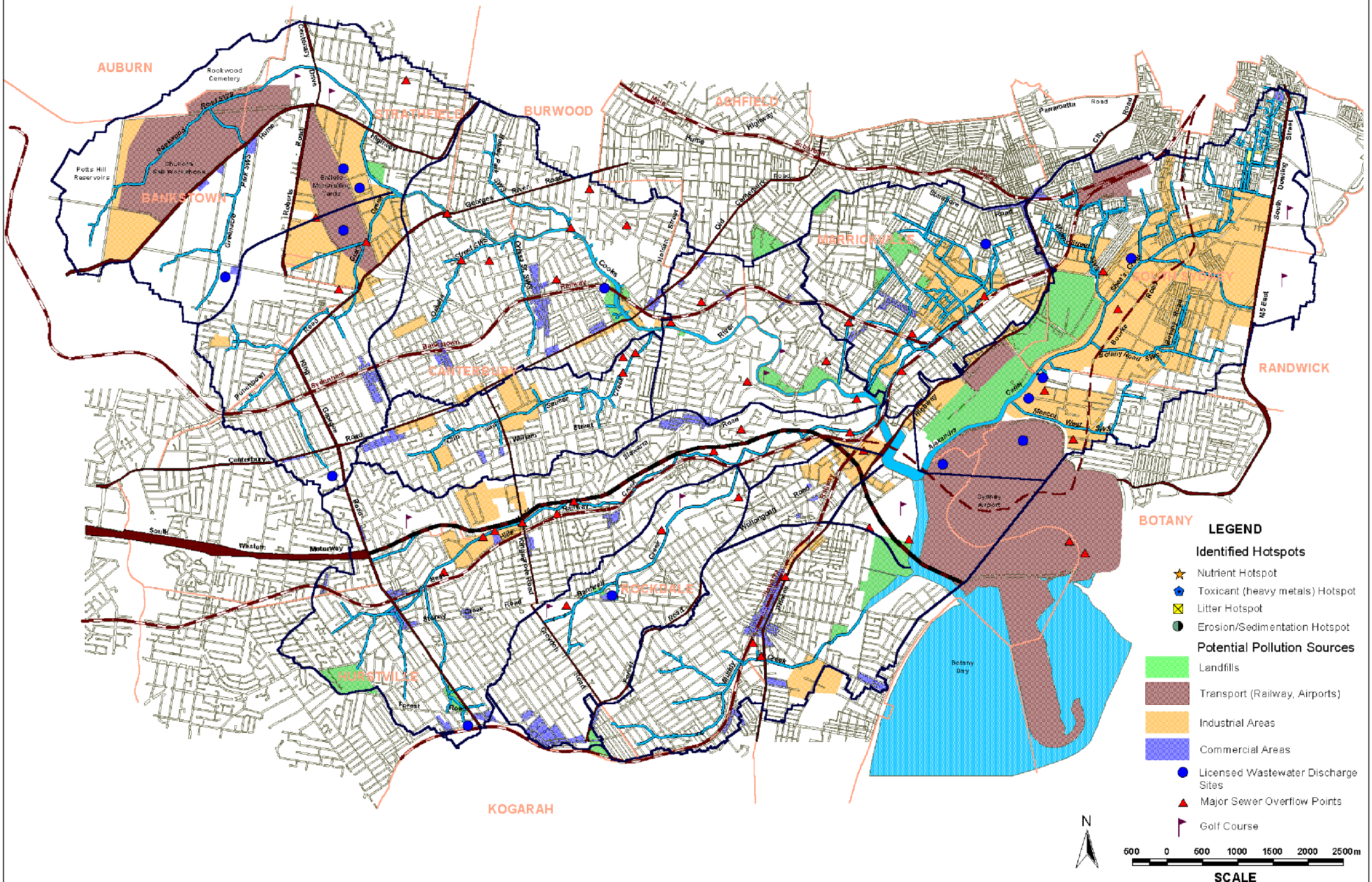
The values of the Cooks River were evaluated at a number of workshops with community and stakeholder groups. Priorities were assigned to each value on a high, medium and low basis. *Table 4.1* represents the agreed prioritisation of values for the Cooks River catchment.

Table 4.1: Summary of Catchment Values of the Cooks River

Catchment Values	Value
Ecological Values:	
Remnants of the original vegetation and creeklines of the River	High
The presence of native water birds, fish and aquatic flora and fauna	High
Visually attractive riparian vegetation along the river banks (weed free)	High
The existing wetland areas and intertidal zone which attract large numbers of waterbirds	High
Remnant vegetation and native animals of special conservation value such as the endangered Cooks River Clay Plain Scrub Forest, and birds protected on international treaties	High
Natural creek banks as opposed to concrete and sheet piling	Medium
Social Values:	
Boating and secondary contact recreation throughout the catchment	High
Swimming in the tidal mouth of the River	Medium
Swimming in freshwater tributaries	Medium
Fishing and consumption of fish caught in the River	High
Recreational areas with water features which are visually pleasing (ie not concrete lined drains)	High
Walking and bike tracks following the River with no visual pollution (that is, no murky water or floating litter)	High
Facilities and use of waterways with environmental education and awareness themes.	High
Economic Values:	
Commercial fishing and oyster farming	Low
Property values improved by waterway location or with views of waterways	Medium
Stormwater suitable for reuse	Medium

Figure 8

Potential Pollution Sources and Identified Hotspots



5. Stormwater Management Objectives

Stormwater management objectives for the Cooks River have been developed to express the outcomes, stormwater managers and the community seek to achieve in relation to the protection of the catchment values identified in Chapter 4. These objectives are consistent with the overall objectives and long term vision for the Cooks River as determined by existing reports such as the Cooks River Catchment Management Strategy, Healthy Rivers Commission, and the Alexandra Canal Water Environment Plan.

Stormwater management objectives include both long term commitments to a vision for the future of the Cooks River and short term quantifiable measures towards these long term objectives (*Table 5.1*). The short term objectives for stormwater management form the basis for identifying management actions that can be implemented and evaluated within a 3-5 year time period.

5.1 Long Term Objectives

The community vision for the Cooks River, as defined through the consultation process, is a healthy, sustainable waterway that can be enjoyed by everyone. Specific water quality objectives and river flow objectives for the Cooks River have been identified as part of the Government's Water Reform initiative. Objectives for stormwater, as a significant contributor to the water quality of the Cooks River, will need to be consistent with these objectives and the long term vision.

Water Quality Objectives

The community's objectives for water quality in the Cooks River have been identified through the consultation process described in *Section 4.1*. The water quality objectives identified by the community are consistent with the proposed interim environmental objectives for NSW Waters (NSW Environment Protection Authority, 1997). As illustrated in *Figure 7*, water quality objectives for the protection of aquatic ecosystems, primary and secondary contact recreation, and visual quality are proposed for various sections of the River.

The long term stormwater quality objectives aim to be consistent with these water quality objectives. This involves meeting ANZECC guidelines (1992) for protection of aquatic ecosystems and primary contact recreation as well as removing visible litter from waterways.

Water Quantity Objectives

Flooding has been identified as a major issue for the Cooks River. Therefore, all actions for improvement in stormwater management aim to ensure consistency with the objectives of Flood Management Plans and environmental flows. Objectives for river flow were also developed through the water reform program (NSW EPA, 1997).

The water quality objectives most relevant to stormwater management in the Cooks River include:

- protect water levels in natural wetlands;
- protect or restore a proportion of freshes and high flows;
- maintain or restore the natural inundation patterns and distribution of flood waters supporting natural wetlands and floodplain ecosystems;
- maintain the rates of rise and fall of river heights within natural bounds;
- minimise the impact of instream structures; and
- maintain or rehabilitate estuarine processes and habitat.

In the past filling and development of the floodplain has occurred along the Cooks River such that natural river flows are almost impossible to recreate. However, in the long term important functions of the flow regime can be restored to the Cooks River. The stormwater quantity objective is to meet these river flow objectives, while recognising the flooding potential of the existing altered waterway.

Ecological Objectives

The ecological objectives for the Cooks River are to protect and restore the remnant aquatic and riparian habitats, and recreate the natural riparian zones and waterways. Improvements in water quality and re-establishment of natural habitats will encourage aquatic species and water birds to recolonise, thereby enhancing the biological diversity of the waterway. As indicated in *Figure 7*, guidelines for protection of aquatic ecosystems are currently met in less than 25% of water samples taken in the Cooks River by the CMC (EPA, 1997).

The Cooks River Foreshore Strategic Plan (Clouston, 1997) defines objectives and strategies for management and rehabilitation of foreshore remnants. A detailed model for restoration of flora and fauna communities across the catchment is also provided. Therefore, the ecological objectives identified for stormwater management in this Plan are limited to the interaction between stormwater and the ecosystem.

Visual Quality and Recreational Objectives

Objectives have also been identified to enhance the visual quality of the river, particularly the removal of visible pollutants, such that the river provides a water feature within a green recreation corridor. The long term social objectives for stormwater are to maximise the visual amenity of the stormwater system and ensure stormwater quality is consistent with desired recreational uses.

5.2 Short Term Objectives

Specific short term objectives for stormwater management are identified in *Table 5.1* and define the collective short term commitments of stormwater managers within the Cooks River catchment. These short term objectives are linked to catchment values

with the overall aim being to improve water quality and recreate natural features of the River ecosystem. The quantifiable short term commitments towards the long term objectives form the basis for the development of stormwater management actions.

Table 5.1: Objectives for Stormwater Management

Catchment Values	Long-Term Stormwater Management Objectives	Short-Term Management Objectives
Ecological Values:		
▪ Remnants of the original vegetation and creeklines of the River ▪ The presence of native water birds, fish and aquatic flora and fauna ▪ Visually attractive riparian vegetation along the river banks (weed free) ▪ The existing wetland areas and intertidal zone which attract large numbers of waterbirds ▪ Remnant vegetation and native animals of special conservation value such as the endangered Cooks River Clay Plain Scrub Forest, and birds protected on international treaties ▪ Natural creek banks as opposed to concrete and sheet piling	1. Protect and enhance remnant foreshore vegetation and natural waterways.	Protect all remnant vegetation of ecological significance and natural waterways from future developments and the impacts of stormwater.
	2. Protect and enhance existing wetlands and intertidal zones from the impacts of stormwater.	Protect all remnant wetlands of ecological significance, remaining floodplain and intertidal areas from the impacts of stormwater from future developments.
	3. Recreate aquatic habitats suitable for native waterbirds and fish	Replace sections of concrete channel with more natural waterway in five areas.
	4. Recreate natural riparian and bushland habitats to act as a buffer zone for stormwater.	Restore the natural riparian zone in three sections along existing natural channels.
	5. Achieve water quality which meets the requirements for protection of aquatic ecosystems in all tidal areas and natural channels (refer to Figure 7 for areas).	Water quality meets the guidelines for protection of aquatic ecosystems in tidal areas and natural channels at least 50% of the time.
Social Values:		
▪ Boating and secondary contact recreation throughout the catchment ▪ Swimming in the tidal mouth of the River ▪ Fishing and consumption of fish caught in the River ▪ Recreational areas with water features which are visually pleasing and safe ▪ Walking and bike tracks following the River with no visual pollution (that is, no murky water or floating litter) ▪ Facilities and use of waterways with environmental education and awareness themes.	6. Achieve water quality which meets the requirements for primary contact recreation in tidal sections of the river and the requirements for secondary contact recreation in all waterways.	Water quality meets the requirements for secondary contact recreation in all waterways more than 75% of the time.*
	7. Maximise the visual amenity of waterways with clear rather than murky water.	Achieve reduction in suspended solid levels in all waterways and control of bank erosion in a sustainable manner.
	8. Maximise the visual amenity of waterways – no floating litter	No significant litter visible in waterways during dry weather and total volume of litter collected in the five key SWC trash racks/GPTs is reduced by 20%.
	9. Achieve water quality meets requirements for consumption of fish	Water quality meets requirements for consumption of fish in the lower Cooks River more than 50% of the time.

Catchment Values	Long-Term Stormwater Management Objectives	Short-Term Management Objectives
	10. Ensure that the stormwater system is of minimal risk to public health and maximise opportunities for environmental education.	Public safety and education considered in the design of all structural stormwater management works.
Economic Values:		
▪ Property values improved by waterway location or with views of waterways ** ▪ Stormwater suitable for reuse	11. Promote reuse of stormwater for irrigation.	Opportunities for irrigation reuse on Golf Courses and new developments considered.

* In making this commitment for stormwater management, Councils note that the presence of faecal coliforms in the waterways is largely a result of overflows and leaks from the sewerage system rather than a stormwater issue.

** The Objectives which correspond to this Catchment Value are identified for Ecological and Social issues, refer to Objectives 3, 4, 7, & 8.

6. Stormwater Management Issues

Stormwater management issues are considered to be factors that currently prevent, or may prevent, the stormwater management objectives identified in Chapter 5 from being realised (EPA, 1998). Environmental, social and managerial issues were identified for the Cooks River, with major issues relating to:

- large volumes of litter reducing visual amenity;
- elevated levels of nutrients and bacteria;
- high concentrations of toxicants;
- lack of co-ordination of management efforts;
- elevated suspended solid levels; and
- loss of natural habitats and poor river health.

Specific stormwater management issues have been identified through the review of existing information as detailed in previous chapters of this Plan. In addition, consultation with Council officers, stormwater managers, Government Authorities, the community and stakeholder groups enabled identification of issues on a sub-catchment basis. Field inspections of the catchment following consultation, enabled identification of specific "hot spot" stormwater problem areas. Hot spots are locations within the catchment which are considered to be pollution sources affecting stormwater quality or impacting on the ecological values of the waterway. Hot spots also include areas that are known stormwater pollution problem areas, such as areas that collect a lot of litter or areas where water quality is particularly poor.

The stormwater management issues, causes and hot spots identified for the Cooks River are summarised in *Table 6.1* and illustrated in *Figure 8*.

6.1 Causes of Pollution

The Cooks River Catchment Management Committee recently undertook a Pollution Inventory of the Cooks River (CRCMC, 1997). This Pollution Inventory involved the compilation of all the potential sources of water pollution and an estimate of their relative impact on the water quality and health of the Cooks River. The outcomes of the Pollution Inventory are summarised in *Figure 9*, which indicates the major water pollution sources and illustrates their estimated impact on water quality in the Cooks River.

Figure 8

Potential Pollution Sources and Identified Hotspots

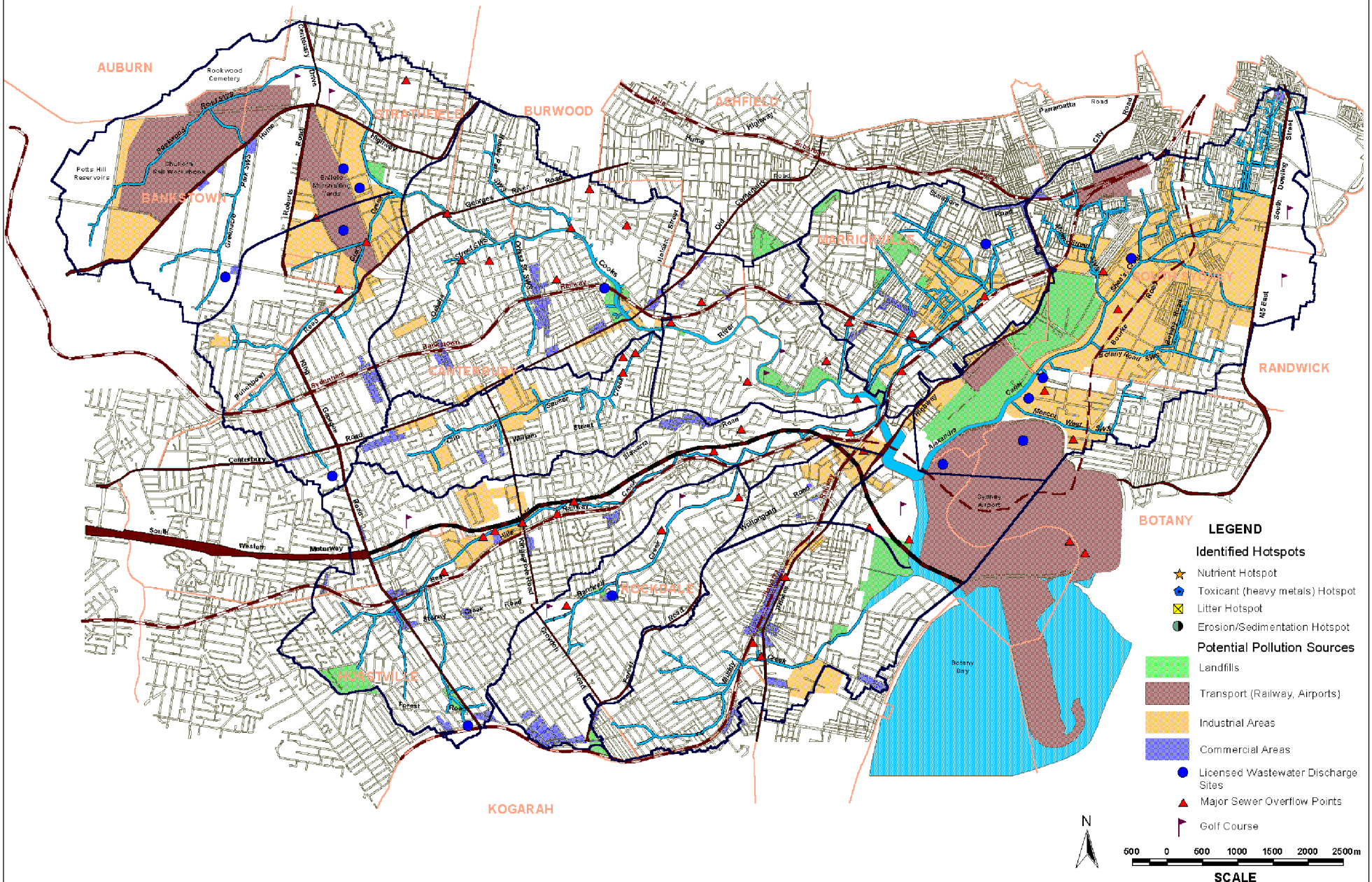


Figure 9: Major Sources of Pollutants and Their Estimated Relative Impact on Water Quality in the Cooks River (Source: CRCMC, 1997)

Based on the outcomes of the Pollution Inventory, pollution loads and sources have been identified for each of the major stormwater management issues (CRCMC, 1997).

Litter

The Pollution Inventory estimated that about 1,300 cubic metres of litter (not including sediment and organic material) are washed from the catchment each year. The main source appears to be streets and gutters in both residential and commercial areas. Other sources identified by the study area were parks, especially those along the river foreshore used for events on weekends. The Pollution Inventory indicated that the most common items of litter were cigarette butts, takeaway food containers, confectionery wrappers, plastic bags, polystyrene packaging and bulkier items such as clothing, furniture, building waste and shopping trolleys.

Major litter hotspots within the Cooks River are identified by *Figure 8*.

Nutrients and Bacteria

The Pollution Inventory estimates the total average annual loads of phosphorus and nitrogen in the Cooks River to be about 50 tonnes and 110 tonnes respectively.

The sewer system is estimated to be the largest source of nitrogen (almost 50%), but is considered to be a less significant source of phosphorus.

Streets are also estimated to be a major source of nutrients, possibly from atmospheric deposition, roadside and domestic fertiliser runoff, and detergents from car washing. Fertilisers used in parks, golf courses, and residential lawns and gardens are another major source of nutrients. Key nutrient hotspots identified for the Cooks River are illustrated in *Figure 8* and listed in *Table 6.1*.

The Pollution Inventory identifies the major source (more than 90%) of faecal coliforms, the indicator of pathogenic organisms (bacteria and viruses), to be the sewer system. It is estimated that about 70% of sewage and coliforms entering the Cooks River do so via five major overflows at Muddy Creek. Minor sources of

bacteria are streets, open space, dog exercise areas, and residential land, presumably from domestic and native birds and animals.

Toxicants

The Pollution Inventory identifies the key toxicants to be heavy metals (lead, zinc, copper and cadmium), oils and grease, pesticides and herbicides.

The Pollution Inventory estimates that about half of the lead entering waterways in the catchment comes from roads (atmospheric fallout from lead petrol, other automotive components). Other significant sources include roofs (atmospheric fallout, lead in roofing and guttering) and poor practices at some industrial premises, particularly some metal fabrications and recyclers. The total average annual lead load is estimated to be about five tonnes.

Galvanised roofing is considered to be the largest source of zinc in the catchment, followed by roads (zinc is used in a number of automotive components) and then small industrial premises (notably some galvanisers) and groundwater inflows from contaminated land. The total average annual zinc load is estimated to be about 23 tonnes.

Copper in roofs, guttering and pipes is considered to be the largest source in the catchment (about half), followed by roads (copper is used in some automotive components) and small industrial premises. The total average annual copper load is estimated to be about three tonnes.

Roofs are also considered to be the largest source of cadmium (almost 50%), followed by contaminated groundwater and roads (cadmium is found in automotive components). The total average annual cadmium load is estimated to be approximately 0.2 tonnes.

Landfills are also considered to contribute to the toxicant load in the Cooks River. Filled sites in the catchment are identified in *Figure 8* and include parts of the Kingsford Smith Airport, large areas along Alexandra Canal, Henson Park, Steel Park, Hurstville Aquatic Centre, Olds Park, Penshurst Park, Kempt Field, Laxton Reserve, Morton Park, Jarvie Park, and Wicks Park (Total Environment Centre 1976).

It is noted that licensed industrial discharges are not considered by the Pollution Inventory to be a significant source of metals, and the sewer system is thought to make only a minor contribution (0-4%).

The Pollution Inventory estimates the total annual load of oils to be about 230 tonnes. The main types of oils and greases in the catchment are considered to be petroleum products and animal and vegetable oils used in foods and cooking. The main source (75%) of petroleum oils is considered to be runoff from the roads, the ultimate sources being vehicles which drip oil and other hydrocarbons, and possibly hydrocarbons in the bitumen road surfaces. Toxicants on road surfaces are likely to bind to sediment and therefore management of sediment from roads will also result in management of toxicants.

Spilt petrol will normally vaporise before it is washed off the catchment, but the heavier diesel fuel may remain and form part of this runoff. Secondary sources include poor practices at some motor vehicle repair premises, fuel depots and outlets and transport companies, and "backyard" mechanics. No estimates were able to be made of cooking and fool oils although it is known that these substances can cause significant pollution when disposed of illegally.

The Pollution Inventory reported insufficient information to estimate sources or quantities of pesticides and herbicides, but considered the major sources to be weed sprays and termite treatment of houses. However, use of chlordane, and other longer living pesticides such as DDT has been phased out, so quantities entering the river can be expected to reduce over time.

Suspended Solids / Sediments

The Pollution Inventory estimated that on average about 11,000 tonnes of sediment is eroded from the catchment each year resulting in murky waterways. Key erosion hotspots along the Cooks River are identified in *Figure 8* and discussed in *Section 3.1*. Sources of suspended solids, including roads, residential blocks, open space, eroding river banks and building and renovation sites. There may be 3,000 construction sites in the catchment at any one time, with perhaps a third involving soil disturbance and thus likely to contribute sediment load.

Other Pollution Sources

Other pollutants identified as impacting on the water quality of the Cooks River include; releases from public and private swimming pools, which may be high in chlorine and suspended solids, runoff from concrete batching plants which may be highly alkaline, and the possible release of acid from acid-sulphate soils. These pollutant sources are considered to be relatively minor in comparison to the major causes of stormwater management issues discussed above.

Table 6.1: Stormwater Management Issues, Causes and Hot Spots in the Cooks River

Issues	Potential Causes	Specific 'Hot Spots' (Figure 8 Reference Location)	Corresponding Objective*
1. Litter in Waterways			
Large volumes of litter including food wrappers, plastic bags, packaging, PET bottles and other forms of litter are all readily visible in the Cooks River. Litter and other gross pollutants are the pollutants Councils receive the most complaints about. Litter is an issue for the Cooks River due to its potential to: ■ degrade the visual quality of the waterways; ■ obstruct existing stormwater controls and transport pollutants; ■ alter aquatic habitats; and ■ become a hazard to recreational users and wildlife.	The litter which ends up in the waterways of the Cooks River is generally thought to come from the following sources: ■ commercial & industrial areas; ■ schools and shopping centres; ■ roads where street sweeping is infrequent; ■ people dumping cigarette butts out of cars and littering generally; ■ parks where there are an insufficient number or type of bins, or bins are uncovered and removal of rubbish is not frequent enough; ■ kerbside recycling bins, particularly PET which is left out for collection and blown away due to delay in collection; ■ fast food outlets; and ■ kids at bus stops, train stations.	■ Large quantities of litter are observed in Muddy Creek estuary following rain events. ■ Parks along the Cooks River foreshore are a significant source of litter. ■ Litter in Bardwell Creek at Shepherd Reserve and Favell Picnic Area. ■ Litter discharging from the Marrickville Piped Subcatchment to the Cooks River. ■ Potential for litter input from Chullora redevelopment area. ■ Litter at the head of Alexandria Canal. ■ Litter from downstream of Campsie industrial area in Cup and Saucer Creek. ■ Litter downstream of Cosgrove Road/ Madeline Street industrial area, Strathfield. ■ Litter discharged from Orissa Street subcatchment. ■ Litter from the Hume Highway in the Upper Cooks River.	Objective 8 Objective 2 Objective 10

Issues	Potential Causes	Specific 'Hot Spots' (Figure 8 Reference Location)	Corresponding Objective*

2. Elevated Levels of Nutrients & Bacteria in the Waterways
 	
Much of the Cooks River is considered to have excessive levels of nitrogen and phosphorus which can lead to:
■ algal blooms and increase of aquatic plant growth;
■ increase in weed growth along waterways;
■ impacts on native plants and animals which can not tolerate high nutrient levels; and
■ health risks in cases where extreme algal blooms are toxic.
	Potential causes of elevated nutrient levels in Cooks River include:
	■ detergents entering the stormwater system from sources such as car washing (private and commercial), industrial and commercial discharges, illegal sewage connection to stormwater;
	■ sewage overflows and leaks from sewerage pipes;
	■ animal droppings, particularly dogs; and
	■ excess fertiliser usage in residential properties, Golf Courses, Council managed recreation areas, commercial nurseries.
		High dry weather nitrogen concentrations in Bardwell Creek, possibly resulting from fertiliser use in Bexley and Bardwell Valley Golf Courses or leakages from nearby sewer main;
		■ Major areas of sewer overflow and exfiltration:
		  ■ Sheas Creek/Alexandra Canal
		  ■ Muddy Creek
		  ■ Overflow at Crn Holmer Street and Illawarra Road
		  ■ Sewerage leak at sugar mill site
		  ■ Sewerage leak at Girraween Park
		■ Very high nutrient levels within Alexandra Canal and Muddy Creek creating eutrophic waterway.
		■ Elevated nutrient levels in Coxs Creek Channel around Madeline Street, South Strathfield.
		■ Elevated nutrient levels in Cup and Saucer Canal.
			Objective 6
			Objective 3
			Objective 5
			Objective 1
			Objective 4
			Objective 2

3. Elevated Levels of Toxicants in the Waterways The Cooks River is considered to have high levels of heavy metals, oils and grease, and pesticides which in areas: ■ represent a health risk to waterway users;	Sources of toxicants in the Cooks River have been identified by a pollution inventory of the catchment including: ■ illegal connections to stormwater from industrial areas; ■ spraying of weeds in parks, and along	■ High metal concentrations in the Kingsgrove Road area of Cup and Saucer Creek possibly as a result of industrial discharges. ■ Metal finishing premises, motor vehicle repairers, chemical manufacturers and	Objective 6 Objective 5 Objective 10 Objective 2

Issues	Potential Causes	Specific 'Hot Spots' (Figure 8 Reference Location)	Corresponding Objective*
■ make it unsafe to eat fish caught in the River; ■ provide a heath risk to aquatic food production for example, recreational fishing; ■ are a risk to aquatic flora and fauna; and ■ result in fish kills.	the drainage lines; ■ houses, roofs and guttering found to be a significant source of Zn, Cu, Pb, Cd; ■ petrol and oils from roads and railways (Note: Pollutants from roads are often attached to sediments) and airborne pollutants; and ■ leachate from landfills.	building sites are the small industrial premises considered most likely to be key sources of oil and heavy metals. ■ Oil pollution in Freshwater Creek thought to be caused by motor wrecker and dismantler business. ■ Leachate input from former landfills at: ■ Tempe Reserve, Marrickville ■ Harp Street brickpit , Campsie	Objective 9
4. Managerial Issues			
There are many stormwater managers within the Cooks River catchment and in many circumstances responsibilities are unclear. For example, if litter generated at a railway station is washed down from one Council area to another where it is deposited on the banks of the river owned by Sydney Water who is responsible for its clean up? Managerial Issues include: ■ inconsistencies in management of stormwater systems between different managers; ■ the ownership of infrastructure and control of stormwater pollution is undertaken by separate authorities; and ■ uncertainty of ownership and responsibility for the river banks and pollution within the river. In addition, there is a lack of awareness of individual and business responsibility with regard to stormwater management.	Potential causes of poor management relate to lack of resources and lack of co-ordination and communication between managers. Examples include: ■ railways are controlled and owned by different departments; ■ within Councils there are different departments with different responsibilities; ■ Sydney Water owns much of the drainage system but is not responsible for stormwater quality and can no longer prosecute under the Clean Water Act; and ■ Public Works/Department of Land and Water Conservation undertook the bank stabilisation works along the River but are not responsible for maintaining them.	These issues apply to all of the waterways within the catchment .	Improved management increases ability to meet all objectives.

Issues	Potential Causes	Specific 'Hot Spots' (Figure 8 Reference Location)	Corresponding Objective*
5. Social			
There are a number of social issues associated with the current state of the Cooks River: ■ odours may occur from deposited materials but are not considered a big issue in the catchment as the concrete lining prevents collection of organic materials; ■ health risks associated with the River being unsafe to swim and unhealthy to eat fish; ■ downstream impacts on Botany Bay; ■ reduction in visual amenity of the waterway; and ■ impact on recreational values.	Sources of odour within the catchment include: ■ organic material decomposing; ■ sewer overflows; and ■ illegal discharge from industrial areas. Health risks causes: ■ poor water quality; and ■ bioconcentration of contaminants in fish. Poor visual quality results from: ■ dewatering metal sheet piling in some areas; ■ litter in the waterways; ■ degraded natural systems; ■ turbid murky brown water in waterways; and ■ removal of natural vegetation and weed growth.	Social issues are linked to a number of other issues identified in this Table and hotspots in regard to social issues are addressed by other sections of this table.	Objective 10 Objective 6 Objective 7 Objective 8 Objective 9
6. Suspended Solids/ Sedimentation			
The Cooks River has elevated suspended solids and turbidity levels which may result in: ■ degradation of the water quality affecting the health of the ecosystem; ■ unsightly waterways due to brown and	Possible causes of high suspended solids and sedimentation include: ■ run-off from construction sites; ■ inadequate or lack of maintenance of erosion and sediment controls;	■ Sediment discharges from construction sites throughout the catchment; ■ Discharges from construction activities such as concrete cutting. ■ Erosion of River banks and drainage lines at:	Objective 7 Objective 2 Objective 1 Objective 5 Objective 3

Issues	Potential Causes	Specific 'Hot Spots' (Figure 8 Reference Location)	Corresponding Objective*
murky water; ■ sediment deposition and as a result an environment for weed growth; ■ changes to channel morphology and therefore altered habitats	■ removal of natural vegetation and riparian vegetation and soil disturbance; ■ high flow velocities over unsealed surfaces; and ■ surface run-off from paved areas.	■ Rookwood Cemetery, stormwater drain along eastern boundary; ■ Chullora Railway Workshop, areas of exposed soil; ■ Enfield Marshalling Yards ■ Cooks River Goods Yards, Sydenham; ■ Banks of lower Bardwell Creek; ■ Cooks River at Fore St, Earlwood. ■ Sludge build-up at Mackay Park, Marrickville. ■ Pool Backwash inputs from Roselands and Canterbury Public Pools.	Objective 4
7. Habitat Loss & River Health			
Changes to habitats and the health of the Cooks River have been significant. The result is a river ecosystem of very poor health with low biodiversity. It is unsafe to fish due to contaminant levels concentrated in the fish flesh. The natural processes that contribute to a healthy waterway are no longer in place. The poor quality of water and ecosystems in the Cooks River also impacts on Botany Bay.	Within the Cooks River aquatic and riparian habitats have been significantly altered due to: ■ weed invasion and litter dumping; ■ removal of natural vegetation throughout catchment; ■ altered stream flow regimes as a result of higher velocity flows; ■ channelisation and piping of natural drainage lines; ■ contamination of water quality to the extent where the river supports only the most resilient aquatic life; ■ foreshore erosion and sediment deposition; ■ steep sided channels with no mud flats	■ Need to protect remnant wetlands in Wolli Creek. ■ Need to manage mangrove growth. ■ Opportunities to recreate habitat at: ■ lower Sheas Creek channel; ■ Chain of Ponds Reserve; ■ Parry Park; ■ Alexandra Canal from Sydney Park; and ■ along banks of the Cooks River.	Objective 1 Objective 2 Objective 3 Objective 4 Objective 5

Issues	Potential Causes	Specific 'Hot Spots' (Figure 8 Reference Location)	Corresponding Objective*
	or intertidal zones; and ■ replacement of natural tributaries with concrete lined open drains and pipes.		

* Objective Numbers identified in Table 5.1.

7. Stormwater Management Options

A range of stormwater management options have been identified to address the stormwater issues identified in *Chapter 6*. Both structural and non-structural options have been identified to minimise or remove stormwater pollutants and achieve the objectives for stormwater management (refer *Chapter 5*).

The stormwater management options identified for the Cooks River were developed through:

- community and stakeholder workshops, and responses to questionnaires;
- discussions with stormwater managers;
- review of existing management strategies such as those proposed in the Cooks River Foreshore Strategy and Alexandra Canal Water Environment Plan;
- identification of existing stormwater management practices and demonstration projects currently undertaken by Councils and stormwater managers within the Cooks River Catchment;
- existing knowledge of best practice stormwater management techniques;
- field inspections of identified hot spot problem areas throughout the catchment; and
- application of expert knowledge and the principles of stormwater management to address outstanding issues.

All stormwater management options identified in this way have been investigated and evaluated according to stormwater management principles and cost-benefit methodology detailed in this chapter. The scope and timeframe for preparation of this Stormwater Management Plan did not allow for detailed investigation of the feasibility of all the structural options. Therefore, some of the proposed options will require further investigation and evaluation to determine their feasibility and detailed cost. Many options however, can be implemented without the need for further investigation/evaluation. This classification of options is discussed further in *Chapter 8*.

Sewer overflows and leaks from sewage pipes were identified in *Table 6.1* as potential causes of elevated nutrients and bacteria in waterways. Options have not bee developed to address sewer overflows and leaks, as Sydney Water are addressing this issue as part of the sewer overflow licensing project and options developed as part of their sewage action plan.

7.1 Stormwater Management Principles

The general principles of stormwater management follows a hierarchy of options:

1. Retain and restore the natural processes of the waterway. Options which maintain the natural drainage and treatment processes (such as wetlands, riparian zones, intertidal zones and natural creek lines) are considered at the top of the hierarchy.

2. Control pollutants at the source. Source control options prevent pollution of stormwater at the source and/or minimise the generation of excess stormwater run-off. Source controls include education programs, innovative design, and management procedures to change polluting behaviour, as well as the installation of infiltration devices to treat pollutants before they enter the river system.
3. Develop "end of pipe" solutions. Options that treat pollutants which have made their way into the river system are considered "end of pipe" solutions. These options are often structural and include gross pollutant traps, sediment detention basins, and litter booms. These options are lowest in the hierarchy as they are often costly and are not preventative.

This hierarchy (NSW Environment Protection Authority, 1998) is consistent with the principles of ecologically sustainable development and also represents the order of cost effectiveness. The development of stormwater management options for the Cooks River follows closely this hierarchy, by focusing on actions which restore a naturally functioning waterway, and control pollutants before they enter the river system. However, in a catchment as modified and polluted as the Cooks River a range options from each level of the hierarchy are required in order to achieve the short and long term stormwater management objectives.

7.2 Options for the Cooks River

The stormwater management options proposed for the Cooks River are listed and ranked in *Appendix G, Table 7.1*. The options aim to address the stormwater issues with a focus on the protection of areas of high ecological value and solving existing "hotspot" problems. Many options are based on pilot studies and trials which have been undertaken within the Cooks River catchment, or on best practice stormwater management techniques. Many of these initiatives are undocumented and require further explanation than can be provided in the table format. Therefore, a summary is provided below.

7.2.1 Natural Processes

Many of the stormwater problems of the Cooks River are a result of large scale removal and modification of the natural processes of the water cycle. Valuable features such as wetlands, floodplains, mudflats, mangrove forests, riparian vegetation, and natural drainage lines have been removed from the majority of the catchment. Many options proposed in this Stormwater Management Plan aim to restore these natural features.

Use of Native Vegetation in the Management of Weeds

Weeds and the existing weed management techniques are identified stormwater management issues for the Cooks River catchment. Weeds occur along waterways, in concrete stormwater channels and along stormwater verges. Weeds out-compete native vegetation communities, reduce habitat for native animals, and may block stormwater flows. The control of weeds can require high maintenance, considerable cost, and spraying stormwater channels with herbicides contributes to stormwater pollution. Current weed management practices within areas of the catchment which contribute to water quality and quantity problems include:

- slashing and mowing weeds and leaving them to enter stormwater drains;
- spraying weeds in concrete stormwater canals with herbicides/weedicide which then flow immediately into the waterways; and
- lack of control such that weeds choke creek lines and cause upstream flooding.

Some innovative weed management techniques have been trialed within the Cooks River Catchment. These include the use of boiling water rather than herbicide to spray weeds.

This technique has proven effective, but costly, as weeds need to be treated more regularly. In addition, there are some concerns regarding the impacts of high temperature water on the waterways.

A more successful trial has investigated the management of weeds through revegetation of stormwater verges with native species. Revegetation trials have been conducted by the Environmental Unit of Sydney Water in four sites within the Cooks River catchment (Durham, 1997). The trials involved the hand weeding and planting of stormwater verges with different combinations of native plants and maintained them, initially for three months. All plants were found to establish well and, after an initial maintenance period, the natives prevented the weed species from growing. *Figure 10* illustrates the success of the program in managing weeds and at the same time recreating a more natural riparian zone to filter stormwater run-off.

The average cost for revegetating with native plants was $22 per metre and $1.20 per metre for maintenance once the plant become established (Durham, 1997). It was found that the larger the site the more cost effective the option, with costs predicted to be as low as $10 per metre for installation and 50 cents per metre for maintenance (Durham, 1997). It was also noted that the types of native plants used on a site must be chosen carefully taking into consideration the soil and sun conditions as well as the type of environment, that is, urban street-scape or bushland. A native species vegetation list for the Cooks River Catchment is provided in *Appendix E*.

The trial concludes that sufficient experience has been gained with native planting's to demonstrate that it is a feasible, attractive, low maintenance alternative to spraying with herbicide (Durham, 1997). Due to the success of these trials this approach to weed control has been identified as an action in the Stormwater Management Plan (refer *Table 7.1*).

Figure 10 Results of Sydney Water Stormwater Revegetation Trials
(Source: Durham, 1997)

Marrickville Valley Stormwater Channel
Native plants following installation in
December 1995

The same site in January 1997.
The *Lomandra longifolia* and Pigface
(*Carpobrotus glaucescens*) are thriving.

River Bank Stabilisation and Rehabilitation

There are a number of best management practices which can be utilised for the stabilisation and rehabilitation of stream banks. Most of the waterways within the Cooks River catchment have been lined either with concrete, stone walls, or sheet piling. Many of these artificial banks are reaching the stage where they require maintenance, particularly the steel piling in the lower section of the Cooks River. This represents an opportunity to rehabilitate the banks with a more natural stream profile where possible, providing the flooding consideration are met. The restoration of natural stream banks addresses key stormwater issues and may result in:

- improvement in water quality as natural vegetation filters some pollutants;
- reduction in sedimentation and erosion as riparian vegetation limits soil loss from stream banks;
- improvement of aquatic and riparian habitat for native species;
- provision of bank stability as root systems can reinforce the soil and thus add substantially to its strength to minimise the potential for bank collapse;
- creation of more visually pleasing waterway and green corridor; and
- reduction of stream velocity in some circumstances where vegetation growth can be used to slow the flow of water in a creek and thereby reduce the potential for scour.

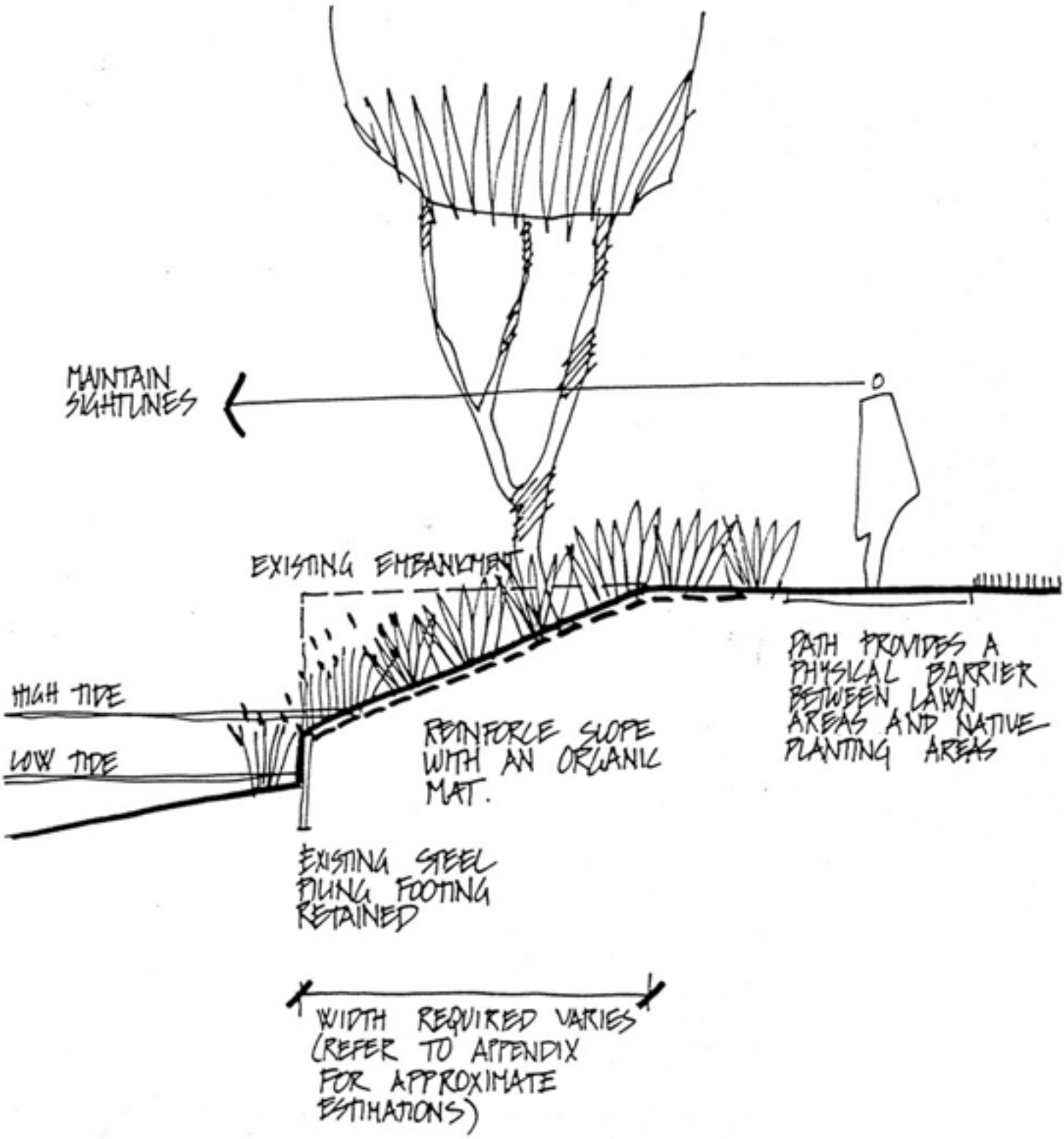
There are a number of hot spot locations along the Cooks River where the banks require urgent stabilisation works. It is most effective to undertake such works in a comprehensive manner rather than addressing small isolated sections. River banks affected by erosion and requiring urgent stream stabilisation works occur mostly along the section of the Cooks 0River where the channel is sheet pile lined (refer to *Figure 8*). Key hot spot areas include the Upper Cooks River at Freshwater Park, Cox's Creek Reserve and Bardwell Creek. The proposed profile for the replacement of steel banks has been illustrated in the Cooks River Foreshore Strategic Plan as illustrated in *Figure 11*. Trial stabilisation planting's using this approach have been successfully undertaken by Marrickville Council between Warren Park and Steele Park along the Cooks River.

The responsibilities for undertaking such works need to be further investigated as ownership and management of these banks is uncertain. The original steel piling works were undertaken by the Department of Public Works and are currently the responsibility of the Department of Land and Water Conservation.

Dechannelisation

Structured watercourses may be dechannelised to enhance the aesthetics of the bank areas and surrounding habitats. Essentially this involves removing the structured element of the channel (that is, concrete pipe or drain) and replacing with natural vegetation, rock, and gently graded banks, to resemble a more natural waterway. Although it is favourable to remove existing concrete lined sections in the tributaries of the Cooks River, the opportunity for dechannelising will be determined by a number of key constraints including:

Figure 11 **Alternative Bank Rehabilitation Profile to Replace Eroding Steel Piling (Source: Cloustans, 1997)**



ALTERNATIVE FOR ERODING STEEL EMBANKMENTS

Where open space widths allow for embankment reconstruction, the benefits are a long term secure embankment, an opportunity for a native vegetation planting, while maintaining sight lines

- the availability of space;
- adjacent land uses and land ownership;
- impacts on flooding and channel hydraulics;
- impact on bank stability; and
- impacts on safety.

Options to enhance the character of the waterways through dechannelisation have been identified in *Figure 16*. Further investigation is required to determine the feasibility of these option. *Figure 12* illustrates the dechannelisation of a concrete drain.

Where space is limited, and flooding is a problem, one alternative is to recreate a natural channel to carry normal flows and pipe flood flows underneath the natural channel. Sydney Water are currently undertaking a feasibility study and concept design for such dechannelisation works in Sheas Creek. The draft concept plan involves a box culvert with gross pollutant trap to convey flood flows, overlain by a macrophyte bed to filter nutrients from normal flows.

Mangrove Management

Mangroves have been successfully re-established in sections of Muddy Creek and are recolonising in other areas of the Cooks River. Mangroves assist in stormwater quality management and are an important habitat for aquatic and intertidal species. Because of the highly altered nature of the river, mangroves re-establishing on recently sedimented sections of the river can cause flooding problems. In addition, mangroves may invade remnant saltmarsh areas. This is occurring at both the Eve Street and Firmstone Gardens wetlands resulting in reduced bird habitat values.

It has been suggested that a Mangrove Management Plan be prepared on a catchment basis for the Cooks River to identify suitable areas for mangrove re-establishment and areas where mangroves are to be controlled. The Plan would be prepared in accordance with the NSW Rivers and Estuary Policy, the Fisheries Management Act and Fish Habitat Protection Plan (No. 1). The Department of Fisheries has supported the preparation of such a catchment wide Mangrove Management Plan.

7.2.2 Source Control

Stormwater quality is potentially influenced by all the land uses and activities undertaken in the catchment. Most of the stormwater management options aim to ensure that each one of those activities is carried out in such a way that the impacts on water quality are controlled at the source. Source control options identified for the Cooks River include a range of education, operational, planning, and management actions as well as' at the source' water quality treatment.

Source control is often the most cost-effective way to manage stormwater. Once the pollution enters the waterway it is far more difficult and costly to treat and mitigate the environmental impacts (NSW Environment Protection Authority, 1998). Most of

Figure 12 **Recent Dechannelisation of a Concrete Lined Drain through Parkland. Works undertaken by Landcom in 1998.**

the options proposed in this Stormwater Management Plan are considered source control options.

Education Programs

Community education is a process used to create awareness of issues, enhance people's knowledge, understanding and skills. Education programs relating to stormwater management aim to influence people's values and attitudes and encourage more responsible behaviour. Education programs can be an effective and powerful tool in preventing pollution of stormwater at the source.

A number of education program have been, or are currently being undertaken in the Cooks River Catchment by various Councils, State authorities, community and environment groups. Some examples of these education programs include:

- *The Drain is Just for Rain*, a comprehensive campaign being conducted by the NSW Environment Protection Authority;
- *Gutters and Garbage Night*, a campaign by Cooks River Valley Association encouraging other residents to clean the leaves out of the gutter and stormwater drain every time you put the garbage out;
- *Solutions to Pollution*, an initiative being trialed in various industries by Councils around NSW;
- *Streets to River Program*, linking the activities of residents in their backyard to impacts on the health of the river; and
- *Stream Watch Program*, a water quality sampling program undertaken by school children.

There are also various information guides available in relation to setting up and carrying out an education program such as, "What we need is - A Community Education Project!" produced by the NSW Environment Protection Authority, to assist Councils in establishing education programs to address environmental issues such as stormwater. The guide is currently available in all Council libraries. The NSW Environment Protection Authority also currently has a stormwater education officer as part of their Education Unit who can assist in the development of stormwater education programs.

Case Study - Streets to Rivers Project

A pilot education program aimed at increasing awareness of the "Cooks River as a natural waterway under stress", is currently being carried out by Marrickville and Canterbury Councils. The program is being implemented in conjunction with the installation of two gross pollutant traps which illustrate ways to reduce the stress on the river.

The results of this pilot program will be used to develop a comprehensive stormwater education package. The program targeted residents, shop owners, school children, builders and contractors, council staff and multicultural groups.

Some of the strategies used in the education program included:

- visiting schools and discussing the project with children, conducting street cleaning excursions, and promoting a launch with school students and the local mayor;
- training volunteers from Sydney University, interested residents, Australian Trust Volunteers, and Green core, in simple stormwater management techniques. Six street parties were held, which included displays, barb-b-ques and even a mural painting. The trained volunteers discussed stormwater issues with residents and distributed information in the form of flyers on preventing pollution of stormwater, stickers and carwash vouchers;
- trained volunteers visited shop owners in local communities and talked with them about preventing pollution of stormwater, waste disposal and self auditing;
- council staff, including street sweepers and cleaners were educated in best practice stormwater practices;
- education officers visited building sites in the catchment to discuss improvement in stormwater management practices with builders and contractors; and
- a team of multilingual volunteers are currently being trained and will also participate in street parties and education of shop owners.

A number of education programs have been suggested as actions in the stormwater management plan (refer *Table 7.1*)

Best Practice in Litter Management

Litter in waterways poses a threat to aquatic ecosystems, human health and is visually unattractive. Providing bins in public places such as parks, shopping centres and on footpaths seems an obvious way to reduce the amount of litter that finds it way into waterways and stormwater channels. People are able to conveniently dispose of takeaway containers, newspapers, drink cans and other wastes in a receptacle rather than drop the rubbish on the ground.

There have been arguments put forward, however, that providing bins can actually lead to more litter as a result of the following:

- animals such as birds, dogs and feral cats disturbing the bins and dispersing the rubbish;
- high winds, blowing litter directly into waterways;
- public bins being used by resident who have filled their personal bins and therefore bins overflowing before being emptied;
- inadequate or untimely waste management service resulting in overflow of bins; and
- recycling bins which allow bottles and paper to blow out or overflow onto the street.

North Sydney Council has removed all bins from public places based on these arguments and considers the litter problem to be improved. Many of the problems proposed above can be prevented if, for example, the bins are provided with lids,

emptied and cleaned regularly, clearly labelled and otherwise well managed. Public Place Waste Management Guidelines are currently being prepared by the NSW Regional Waste Planning and Management Boards to assist local Councils and other public authorities to implement effective public place waste management systems and encourage the provision of recycling facilities. Due to the success of these trials in some local council areas, it has been suggested a trial be carried out of the various approaches to determine the best solution for the Cooks River Catchment.

Street Sweeping

Most Councils within the Cooks River already undertaken an extensive street sweeping program. Dry street sweeping removes litter and sediments (which toxicates land) from roadways in commercial and residential areas. Street sweeping is a relatively costly stormwater management action, however, street sweeping is undertaken to address a number of additional Council responsibilities such as maintaining the visual amenity of business centres and suburban areas as well as being public health and safety measures.

For this reason, it si a management action that Councils consider is required, even though it appears expensive as a stormwater management option.

Education/Training and Auditing of Industry

Auditing of industry and commercial activities in relation to stormwater management is an effective enforcement and regulation tool as well as an education tool. Auditing of an industrial or commercial premises will enable detection of illegal stormwater connections, illegal discharges to stormwater, potential discharges from material not properly contained, for example, oils drum not contained in a bunded area, poor practices such as sweeping materials into gutters etc. Regular audits are currently carried out by (which councils) of premises which they are responsible for regulation of under the *Clean Waters Act*, *Clean Air Act* and *Noise Control Act* as well as commercial premises.

An example of an effective audit program which focused on education, training, review and, as a last resort, enforcement was recently carried out in the Alexandra Canal Catchment. The project funded through the NSW Environment Protection Authority involved auditing of all industrial and commercial premises in the Alexandra Canal catchment.

The program was 100 percent successful with all industry complying with guideline within a six month period. Options to continue such a program in other areas of the catchment are included in the Stormwater Management Plan.

Non-Polluting Alternatives

Many polluting practices can be prevented with the implementation of alternative methods which do not impact on stormwater quality or quantity. A number of innovative source controls are currently being trialed throughout the Cooks River Catchment.

Fertilisers applied to sports grounds, parks, golf courses, and used in commercial nurseries are a source of nutrients in stormwater run-off. Worms are being trialed by

Marrickville Council as a replacement for fertiliser on Steele Park Oval. To compare results, both worm casting and fertiliser techniques have been used on half of the oval and a visual assessment is being recorded.

Another natural alternative being trialed is the use of Dung Beetles to process pet droppings. Strathfield Council is currently trialing this innovative strategy in its public parklands and Randwick Council has successfully trial this strategy.

Stormwater Filtration Systems

Several methods are available to treat stormwater by filtration prior to discharge to the municipal system, including:

- sand filters - collected run-off passes through coarse graded sand media before discharging into the drainage system; and
- drainage cells - plastic drainage cells surrounded in a geotextile and buried within an amended media that filters run-off. Removes both dissolved and suspended pollutants.

Opportunities for installation of such filtration systems at minor stormwater pipe discharge points are recommended for further investigation in the Stormwater Management Plan.

Landfill Remediation

There are a number of landfill sites within the catchment, as shown in *Figure 8*. These typically consist of original drainage gullies and riverside areas that have been infilled over the last 90 years or so with domestic and (at times) industrial waste. These areas are a potential pollutant source due to ongoing migration of pollutants to the stormwater and drainage system in leachate.

Control and treatment measures include systems for recycling of leachate and treatment of leachate by bio-remediation. Further investigation into suspected sites where leachate generation is a potential problem is recommended.

7.2.3 Structural "End of Pipe" Options

Structural options for stormwater management generally involve high capital costs for installation. In addition, as these structural solutions tend to 'clean up' rather than prevent the problem there will always be ongoing maintenance costs.

The capital costs can be prohibitively high, and in addition there are ongoing maintenance costs to the community, local Government and Sydney Water Corporation. Therefore, in identifying structural options for the Cooks River, the following criteria have been applied to identify areas where structural options would be most appropriate:

- hotspot areas - these are areas that are presently very degraded and require treatment and improvement within a time scale which cannot quickly be met by non-structural options;

- areas of high ecological value - including existing areas of high ecological significance which require environmental safeguarding, and degraded areas of ecological significance which are in need of enhancement or improvement;
- areas of high community value - including existing and potential areas of high community use such as public recreation areas;
- public health and safety - areas where public health and safety is at risk, or is in danger of becoming so;
- effectiveness - that a structural facility would result in tangible and measurable improvements in stormwater quality;
- flow conditions - the location needs to be suitable in terms of water levels, tidal variations and flooding conditions;
- land constraints - particularly land requirements and topography which allows the development of a facility without considerable land resumption or other disturbance;
- adjacent land uses and available access areas for continued operations and site maintenance; and
- aesthetics - the siting of a facility should not result in a degradation of the aesthetics of the area.

The following discussion briefly outlines the merits and issues for some of the structural strategies most applicable to the constraints of the Cooks River catchment.

Trapped Street Gully Pits

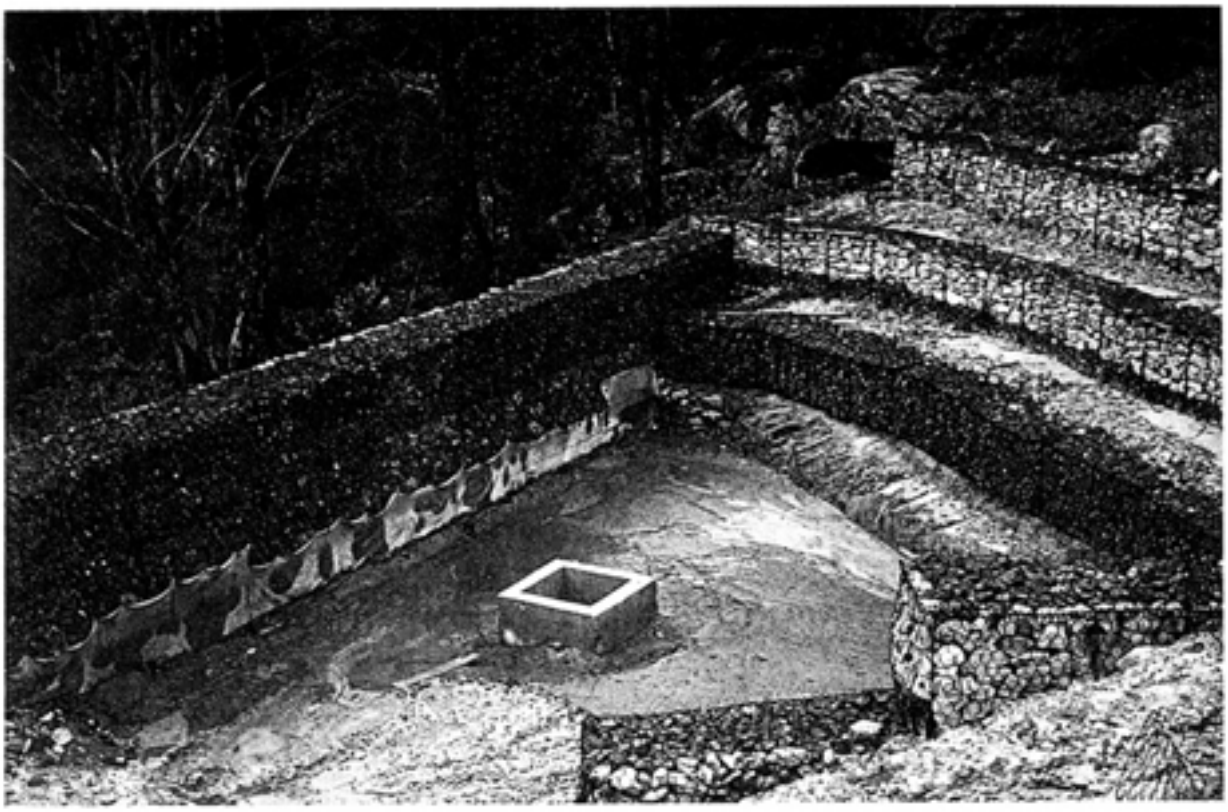
These are modified pits with baffles used to retain sediments and floating material from road run-off. Baffle plates fitted in the drainage pits are used to facilitate the settlement of heavy sediments and the containment of floating debris (including litter, grease and oil) inside the pit. There are some 26,000 pits in the stormwater system of the Cooks River Catchment. The effectiveness of the pits has been demonstrated by South Sydney Council, who notes that their effectiveness is dependent on regular maintenance.

Trapped street gully pits have been recommended for installation at appropriate hot spot locations along roadways (refer Litter Hot Spot Actions in *Table 7)*. The costs associated with installing (and ongoing maintaining and cleaning) are substantial. For that reason it is recommended that a pit would only be modified to include traps at hot spot locations or at the last pit before discharge to waterways.

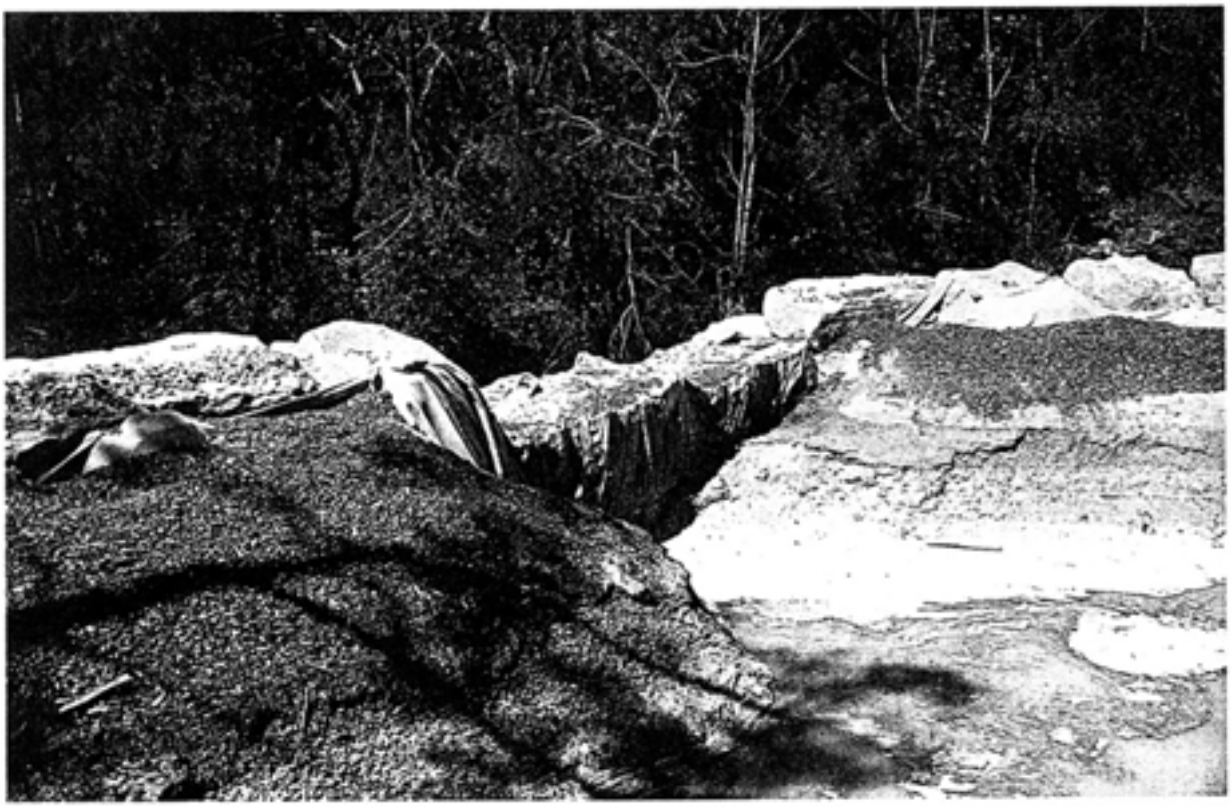
Detention Basins

Where space is available detention basins might be constructed to temporarily hold the floodwaters and release them at a rate no greater than the downstream system capacity, see *Figure 13*. Detention basins for small urban catchments are best located near the top of the catchments. Level open space areas suitable for construction of a detention basin (for example, within public reserves) are very limited in developed areas. When siting detention basins on public reserves, consideration should be

Figure 13 **Sediment Retention Basins**
(Source: Managing Urban Stormwater, 3rd edition 1998, Landcom and Housing)



A sediment retention basin constructed on Type C soils with gabion baskets in very steep country. The structure has recently been converted to a constructed wetland.



A sediment retention basin constructed on Type C soils from local sandstone gibbers

given to incorporating existing uses of the reserve, and in maintaining aesthetics, and existing vegetation wherever possible.

The development of detention basins in parkland area such as Hughes Park along Cup and Saucer Creek requires detailed investigation. There may be potential for detention basins to be developed on lands planned for redevelopment although this has not been identified in this plan.

On-Site Detention

On-site detention is a method of reducing peak stormwater flowrates through temporary storage in basins or tanks within a development (residential lot, block of units, etc). On-site detention also has a subsidiary (and generally unquantifiable) benefit in reducing sediment and nutrient transport from a development to the municipal stormwater system. The benefits of on-site detention depend heavily on appropriate maintenance of the system by the landowners. On-site detention policies are in effect with most of the Councils in the Cooks River catchment.

Sediment Traps and Gross Pollutant Traps

A sedimentation trap is typically installed to prevent coarse sediments from being conveyed to receiving waters, which would lead to siltation problems and increases in nutrients. A trap is generally designed to remove approximately 75 percent of medium silt and coarser fractions of sediment. This is achieved by reducing inflow velocities to allow differential settling of the particles to occur. Regular maintenance of the trap is required to remove the build-up of sediments. In general, a minimum of three months depositional volume should be provided.

The incorporation of a trash rack with the sediment trap constitutes what is known as a Gross Pollutant Trap, see *Figure 14*. The additional function of this facility is to remove trash and debris from the stormwater flow. These types of structures are used near the outlet of an urban drainage system, upstream of a watercourse, water body or wetland.

The major function of the gross pollutant trap is to protect the aesthetic and environmental quality of downstream water bodies or wetlands by limiting the rate of sedimentation and intercepting trash and debris. This ensures protection of macrophyte and bird habitats and maintains the visual quality of downstream areas.

As detailed in the issues report there are a number of existing gross pollutant trap's installed within the Cooks River system. These traps catch enormous volumes of litter and have significant ongoing maintenance costs. The five traps managed by Sydney Water captured just under 1000 cubic metres of litter and cost over $330,000 to maintain per year (Sydney Water, 1998).

The use of sediment traps has been recommended for further investigation at industrial sites such as Chullora Railway Workshops and Enfield Marshalling Yards. Gross pollutant traps have been identified as an option at a number of locations in the upper catchments (Bardwell Creek, Upper Cooks River) and would require further investigation particularly in terms of their effects on mainstream flooding, land requirements and available access to the site. There is limited scope for the development of gross pollutant traps in the tidally affected portions of the creeks.

Figure 14 **Gross Pollutant Trap**
(Source: Pollution Control Manual for Urban Stormwater, State Pollution Control Commission)

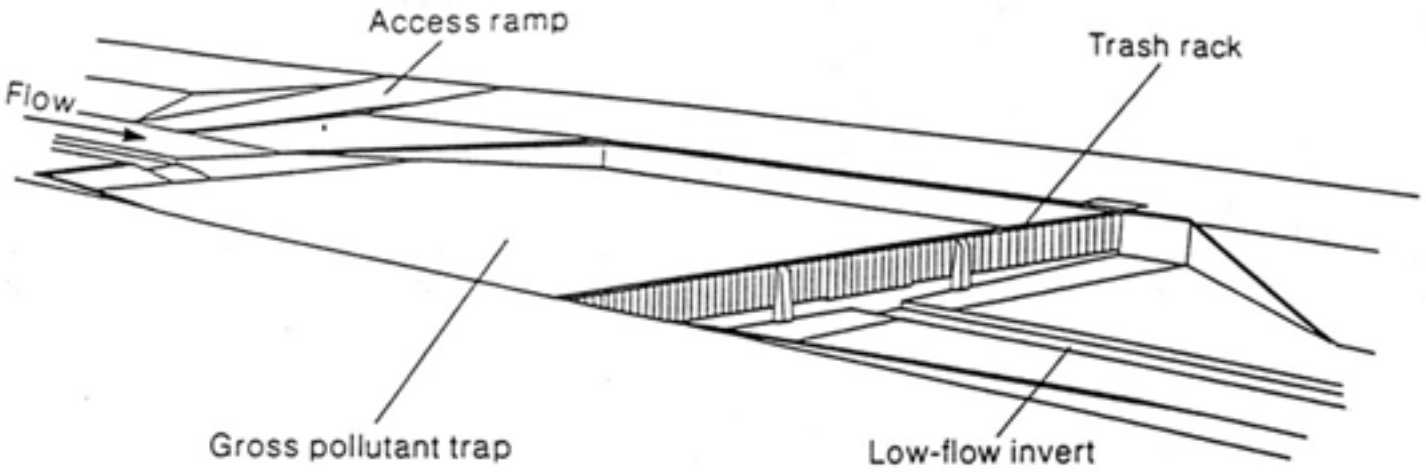
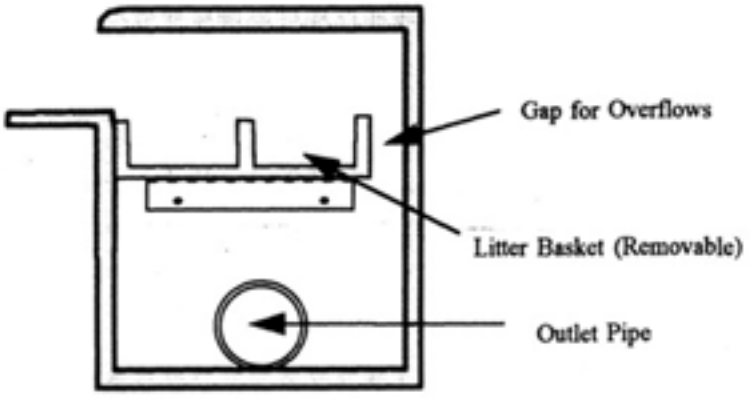


Figure 15 **Litter Basket**
(Source: Managing Urban Stormwater, Treatment Techniques, NSW Environment Protection Authority)



Schematic of a Litter Basket

Other Litter Control Devices

There are a number of alternative devices available to control litter and debris depending on the situation. These include:

- litter baskets - a wire or plastic basket installed in a stormwater pit to collect rubbish either directly entering the system from road surfaces, or from within the upstream piped drainage system, see Figure 15;
- litter booms and nets - these are floating booms with mesh skirts placed across a waterway (channels or creeks) to collect floating and partially submerged (waterlogged) trash and debris;
- minor gross pollutant interceptors/traps - end of line treatment comprising collection bags or nets which require regular replacement; and
- proprietary devices designed to separate coarse sediments, trash, debris, and some sediments within the stormwater drainage system. These include such devices as the Continuous Deflective Separator units (CDS), Downstream Defender and In Line Litter Separator.

A coarse log trash structure is recommended for investigation along Bardwell Creek, whereas trash racks are considered as part of gross pollutant traps as previously discussed.

Litter baskets are recommended at several locations and would require a high degree of maintenance to be effective.

Litter booms were not generally recommended, as appropriate locations for their installation was limited. The booms tend not to be effective along the tidally affected sections of the river and creeks as litter washes back upstream with the change in tides. There are insufficient flows to support the use of these structures in the upper reaches of the waterways. Litter booms also require a high degree of maintenance and are susceptible to vandalism.

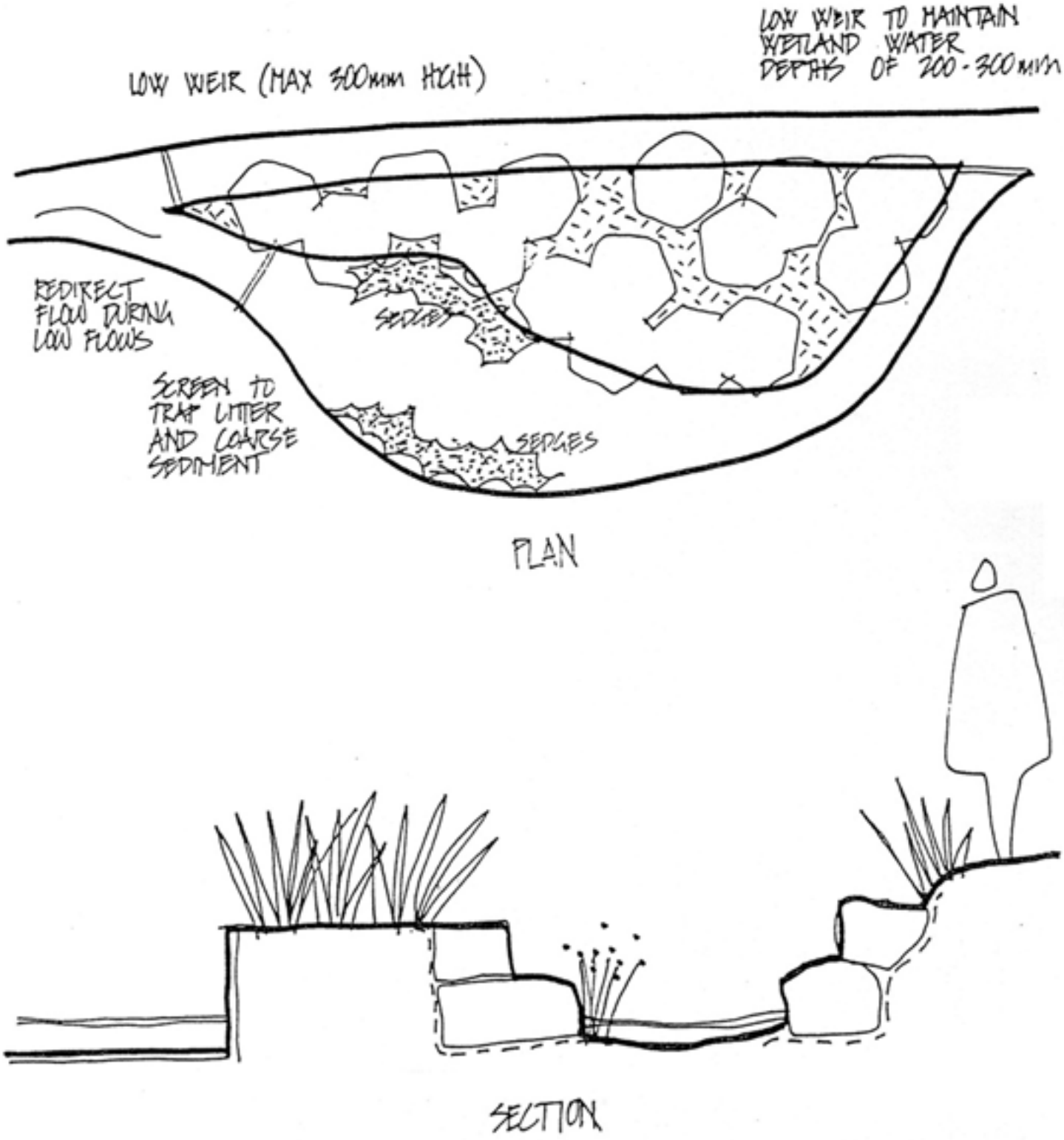
Minor gross pollutant interceptors/traps and proprietary devices are recommended at the end of several drainage lines. Further investigation is required particularly on the impact of the device on the aesthetics of the area and the level of maintenance required for these structures.

Constructed Wetlands

Constructed or artificial wetlands have been used for some years for treatment of sewage effluent, and are now also being adopted for stormwater quality improvement, see *Figure 16*. The main purpose of these wetlands is to encourage settlement of suspended sediment particles including organic and mineral solids, and to reduce nutrient concentrations. Approximately 10 percent of nutrients are removed through plant (macrophyte) uptake, nitrogen is released to the atmosphere by bacteria (microfilm) on plant surfaces and phosphorus typically attached to sediments is settled out.

Additional benefits include improving the aesthetic and recreational quality of the area and providing faunal habitat. Providing a gross pollutant trap upstream of a

Figure 16 Typical Linear Wetland
(Source: Cloustans, 1997)



It should be noted that the area of constructed wetland technology is one requiring input by professionals with expertise in wetland ecology and hydrology. Artificial wetlands usually have a relatively short life-span of 5-10 years before major reconstruction is required. They can also become a source of weed infestation if not carefully managed.

TYPICAL LINEAR WETLAND CONSTRUCTION

wetland reduces the load of coarse sediments and trash introduced into the wetland, thereby preserving the aesthetics of the wetland and reducing the maintenance requirements.

Wetlands are recommended for investigation at several areas including along Cup and Saucer Creek, Cox's Creek at Cox's Creek Reserve, Greenacre Park SWS, Muddy Creek, Upper Cooks and Omaha Canal. Some areas have existing remnant vegetation or are situated within or along side parkland which have the potential for incorporation into a wetland area.

It should be noted that to attain adequate stormwater quality improvements, wetlands have large land area requirements (typically between 0.5 percent and 2.0 percent of the upstream catchment). In a fully developed catchment such as the Cooks River, available space is very limited, and it is unlikely that the optimal amount of space would be available. The benefits of a wetland need to be carefully evaluated at the investigation stage, taking account not only of the water quality improvements, but also the associated environmental, recreational and aesthetic values.

A number of locations have been identified for installation of offline wetlands which run parallel to the river channel.

7.3 Evaluation of Options

All the options proposed for management of stormwater in the Cooks River Catchment (*Appendix G*, *Table 7.1)* have been assessed on the basis of their costs and benefits. The methodology developed by the NSW Environment Protection Authority (1997) has been adopted with minor changes to assess the identified management options. This methodology provides a management tool to enable the prioritisation of solutions to stormwater problems. This simplistic and somewhat objective methodology has a number of limitations. However, the basis for evaluation of each option is transparent and judgement may be used in the interpretation of the results.

Each of the columns in *Table 7.1* is described below along with details of the methodology used to evaluate and rank the options. The location of the structural options presented in *Table 7.1* are indicated on *Figure 17* according to the Option number.

Options

The first four columns in *Table 7.1* provide information on the option as follows:

OPTION NO. : This is the management option number assigned for ease of reference.

WATERWAY: This column indicates the sub-catchment the action is targeting. Refer to *Figure 5* for sub-catchment boundaries.

ALL- the whole catchment
UP - Upper Cooks River sub-catchment
CO - Middle Cooks River sub-catchment

LC - Lower Cooks River sub-catchment
AC - Alexandra Canal and Sheas Creek sub-catchment
MA - Underground piper system in Marrickville area
MC - Muddy Creek sub-catchment
BC - Bardwell Creek sub-catchment
WC - Wolli Creek sub-catchment
CS - Cup and Saucer Creek sub-catchment
CX - Coxs Creek sub-catchment

AUTHORITY: This column indicates the responsible agent for co-ordinating the implementation of the action. Many actions are most successful if all stormwater managers work together.

ALL- C - All Councils to implement as a co-co-ordinated effort
ALL - All stormwater managers to implement in their areas
ASH - Ashfield Council
AUB - Auburn Council
BANK - Bankstown City Council
BOT - Botany Bay City Council
BUR - Burwood Council
CANT - Canterbury City Council
HUR - Hurstville City Council
KOG - Kogarah Council
MAR - Marrickville Council
RAN - Randwick Council
ROC - Rockdale City Council
SSC - South Sydney Council
STRA - Strathfield Council
RTA - Roads and Traffic Authority
Rail - All Rail Authorities including SRA, NRS, RAC, FC
EPA - Environment Protection Authority
EDDept- Education Department
FISH - Department of Fisheries
GA - Greening Australia
SWC - Sydney Water Corporation
CRCMC- Cooks River Catchment Management Committee
WA - Waterways Authority

STRATEGY TYPE: The options have been categorised into:

ED - Education
MAN - Management
ST - Structural
AU - Auditing / Enforcement

DESCRIPTION: Describes the option.

Costs

In this cost benefit evaluation of options, costs are determined as follows:

INSTALLATION: The estimated initial cost involved to implement the option. Includes feasibility studies and structural costs. See *Table 7.2* for relative weightings.

MAINTENANCE: The estimated cost for ongoing maintenance over a 10 year period. It was decided by stormwater managers to use a period of 10 years as it is envisaged that most of these options, and in particular the structural options will be carried out for a long period of time. Therefore over 10 years the cost of installation will be more fairly balanced against the maintenance cost. See *Table 7.2* for relative weightings.

Table7.2: Costs - Installation and Maintenance/Operating

Cost	Weighting
less than $50,000	1
$50,001 - $100,000	2
$100,001 - $200, 000	3
$200,001 - $400,000	4
$400,001 - $600,000	5
$600,001 - $800,000	6
$800,001 - $1,000,000	7
$1,000,001 - $5,000,000	8
$5,000,001 - $10,000,000	9
$10,000,001 +	10

NOTE: If all councils are to implement as a co-ordinated effort (ALL-C), costs identified are total approximate cost for implementing the option. Councils will need to negotiate proportional payments.

Where an action requires investigation only, no ongoing maintenance cost is required. Also, where options require a Council Officer's time to implement, costs are estimated using a guide of $1000/week/officer.

COST INDEX: Is the combined total of the capital and maintenance cost. An index of 10 indicates the highest cost options and an index of one indicated the lowest cost option. It should be noted that this is a relative, not a definite index.

The capital and maintenance costs used to rank and assess the structural options have been selected from a range of source material which includes:

- Stormwater Management Plans previously developed by the consultant team;
- The Cooks River Foreshores Strategic Plan;
- discussions with Council and Sydney Water Corporation personnel;
- supply costs provided by manufacturers of proprietary systems; and
- construction costs for stormwater facilities designed by the consultant team.

The costs shown are indicative of the type of facility indicated, and reflect to some degree the size or complexity of a facility placed in the location shown. However, these costs are very approximate, and are used solely for the purposes of comparative ranking of the options. The cost for any particular option will need to be refined and confirmed by further, more detailed, investigation.

Benefits

The benefits of each option have been assessed based on the following considerations:

TARGET POLLS: The pollutant most likely to be affected by implementation of the management option. See *Table 7.3* for weightings of the relative harm of each target pollutant. In this context relative harm refers to potential environmental impact.

Table 7.3: Target Pollutants and their Relative Harm (NSW Environment Protection Authority, 1998)

Target Pollutant	Relative Harm
Litter	2
Nutrients	4
Sediments	4
Weeds	5
Bacteria	5
Oil & Grease	6
Organic Matter	7
Heavy Metals	7
Toxins	8

NO. POLLUTANTS: The number of pollutants which are likely to be captured/affected by the management option.

REL IMPACT: Based on the existing water in the Cooks River Catchment, stormwater managers allocated relative weightings to each pollutant. This allows for catchment specific weighting of stormwater pollutants. See *Table 7.4* for relative weightings.

Table 7.4: Relative Level of Pollutants for the Cooks River Catchment

Impact	Weighting
Litter	6
Nutrients	5
Sediments	5
Weeds	5
Bacteria	5
Oil & Grease	6

Organic Matter	7
Heavy Metals	7
Toxins	8

AREA: The area of the catchment that the management option potentially benefits - described in hectares. See *Table 7.5* for relative weightings.

Table 7.5: Area - Proportion of Catchment the Management Option Potentially Benefits

Hectares	Area percent	Weighting
0 – 1000	0 - 10 %	1
1001 – 2000	11 - 20 %	2
2001-3000	21 - 30 %	3
3001-4000	32 - 40 %	4
4001- 5000	41 - 50 %	5
5001-6000	51 - 60 %	6
6001-7000	61 - 70 %	7
7001-8000	71 - 80 %	8
8001-9000	81 - 90 %	9
9001-10000	91 - 100 %	10

EFFECTIVENESS: The effectiveness of the option in managing the pollutant. See *Table 7.6* for relative weightings.

Table 7.6: Effectiveness - The Effectiveness of the Option in Managing the Pollutant

Effectiveness	Weighting
Low	1
Med-low	3
Medium	5
High-med	7
High	10

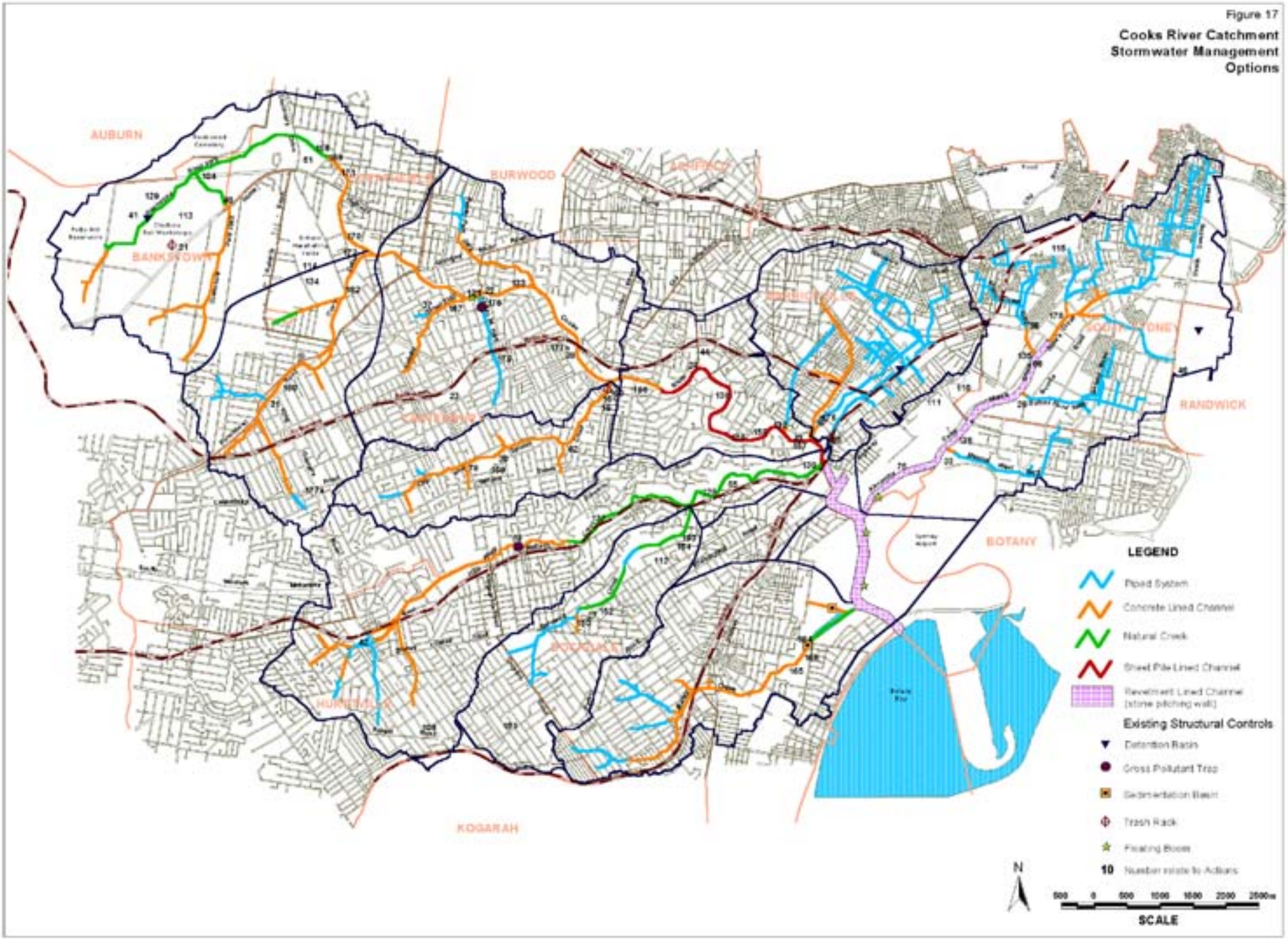
EDUCATION: The level of education awareness, and consequently enhanced source control, the option will provide to the community. See *Table 7.7* for relative weightings.

Table 7.7: Education - The Level of Education Awareness the Option will Provide to the Community

Effectiveness	Weighting
Low	1
Med-low	3
Medium	5
High-med	7

Figure 17

Cooks River Catchment Stormwater Management Options



High	10

BENEFIT INDEX: The sum of the benefits divided by six. Note each benefit column has been assigned a number between one and 10, 10 being the most desirable outcome and one being the least desirable benefit.

Ranking of Options

Finally each option is ranked according to its cost- benefit which is calculated as follows:

COST/BENEFIT: The cost benefit ratio is calculated by dividing the cost index by the benefit index. The lower the number the more desirable the option. that is, one is the best and ten is the worst.

Cost Benefit score	=	Cost Index	/	Benefit Index
(the smaller the number the "better" the option)		(the lower the number the cheaper)		(the higher the no. the better)

RANK: The overall rank of the option, one being the most favourable ranking.

7.4 Current Stormwater Management Practice

There are many stormwater managers within the Cooks River catchment who can influence the quality of stormwater through internal operations, management and planning controls. As part of the Stormwater Management Planning process, the Environment Protection Authority has requested that Councils review their internal activities and ensure they are setting an example to the community (NSW Environment Protection Authority, 1998). The existing stormwater management actions undertaken by Councils and key stormwater managers within the Cooks River catchment are summarised in *Table 7.8.*

One option put forward in the Stormwater Management Plan aims for consistency in stormwater policy across the entire catchment. This is an important action which involves setting criteria and guidelines for stormwater management to be increased by all Councils in their Planning Controls and Management Plans. The generic Stormwater Policy would standardise sedimentation controls, development requirements, revegetation policies, contractor performance criteria, industry standards and other actions relevant to best practice stormwater management policy and procedure for the catchment. This exercise would draw on existing policies and management plans implemented by Councils throughout the catchment and produce a powerful management tool. In other catchments, such a stormwater management policy has been incorporated within a Regional Environmental Plan. This is one option for incorporating guidelines within the planning framework. An alternative is for all Councils to incorporate the Policy within their Local Environmental Plans. The second method is more readily implementable in the short term.

Councils currently have limited powers to prevent, prosecute or order the clean-up of pollution of waters under existing legislation such as the *Clean Waters Act 1970*, *Pollution Control Act 1970* and *Environmental Offences and Penalties Act 1989*. However, with the introduction of the *Protection of the Environment and Operations Act*, to replace the above Acts, Councils will receive much stronger regulatory powers very similar to those currently held by the NSW Environment Protection Authority, excepting control of scheduled activities regulated by the NSW Environment Protection Authority. Notable key powers relate to clean up and prevention notices, on-the-spot fines, powers of entry and obtaining information and legal action. These increased powers under the new legislation are detailed in *Appendix F*.

Table 7.8: Existing Stormwater Management Actions

Existing Stormwater Actions	Councils												
	Ashfield	Auburn	Bankstown	Botany	Burwood	Canterbury	Hurstville	Kogarah	Marrickville	Randwick	Rockdale	South Sydney	Strathfield
Internal Management													
Allocation of stormwater management responsibilities and resources (people and funding).	✓	p	P	p	p	p	p	✓	✓	p	P	✓	✓
Internal communication between departments of organisations and with community regarding stormwater issues.	✓	p	P	p	p	p	×	✓	p	p	P	✓	✓
Internal procedures for operations staff and contractors.	✓	p	p	p	p	p	×	✓	p	×	×	p	p
Education and training of employees in stormwater management practices.	p	×	×	p	p	p	p	p	✓	×	p	p	p
Performance monitoring of staff in following stormwater management procedures.	×	×	×	×	p	×	×	p	p	×	×		p
Stormwater Planning Controls													
Stormwater Policy	✓	×	×	p	✓		p	✓	✓	✓	×	✓	✓
Strategic Planning for Stormwater and Catchment	p	×	p	×	p	p	×	✓	p	p	p	p	p
Development Controls	✓	×	p	p	✓	✓	✓	✓	✓	✓	p	✓	p
Building Approvals and Inspection	✓	p	p	p	✓	✓	✓	✓	p	p	p	✓	p
Planning provisions for stormwater management (eg. Shopping centres required to install at source GPT, residential subdivision required OSD):													
• Residential	✓	×	×	×	×	p	p	✓	✓	✓	p	p	✓
• Commercial	✓	×	p	p	×	p	p	p	✓	✓	p	p	✓
• Industrial	✓	×	p	p	×	p	p	p	✓	✓	p	p	✓

Key
- ✓ Action already adequately addressed
- p Action partly undertaken but could be improved
- × Action not undertaken
- n/a Action not applicable

Existing Stormwater Actions	Councils												
	Ashfield	Auburn	Bankstown	Botany	Burwood	Canterbury	Hurstville	Kogarah	Marrickville	Randwick	Rockdale	South Sydney	Strathfield
Stormwater Related Actions/Operations													
Street sweeping.	✓	✓	✓	p	✓	✓	✓	✓	✓	✓	✓	✓	✓
Auditing of illegal stormwater connections.	×	p	p	×	×	×	p	×	✓	×	×	✓	n/a
Regular auditing of industry.	×	×	p	p	×	p	×	✓	✓	p	P	p	p
Community education campaigns:													
• Litter	×	×	p	×	×	p	×	p	✓	×	×	p	p
• Sediment and erosion	×	×	p	×	×	p	×	p	✓	×		✓	p
• Nutrients (fertilisers, carwashing)	×	×	p	×	×	p	×	p	p	p	p	p	p
• Weeds	×	×	×	×	×	p	✓	✓	×	p	×	✓	p
• Toxicants (oils and grease, chemical use)	×	×	×	×	×	p	×	p	p	p	p	✓	p
Provision of GPT's, litter baskets etc	p	p	p	p	×	p	p	✓	p	p	p	p	✓
Weed removal and bush regeneration	✓	p	p	p	n/a	p	✓	n/a	p	n/a	p	✓	✓
Drain Stencilling	×	×	✓	p	p	p		p	p	×	p	✓	✓
Maintenance of stormwater infrastructure (eg. Clean drains and traps)	✓	p	p	p	✓	p	✓	✓	✓	✓	p	✓	✓
Waste management procedures	✓	p	×	p	×	p	×	p	✓	p	p	✓	p
Leachate management and remediation of owned contamination sites	✓	×	p	n/a	n/a		✓	n/a	×	n/a	×	p	p
Other: Promotion of water conservation and reuse									✓				
Monitoring													
Mapping of stormwater infrastructure	✓	×	×	p	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water quality monitoring.	×	p	✓	p	×	×	×	×	×	×	p	✓	p
River health assessment.	×	×	p	×	n/a	n/a	×	n/a	p	n/a	p	p	n/a
Other: Monitoring sediment in gully pits												✓	

Key
- ✓ Action already adequately addressed
- p Action partly undertaken but could be improved
- × Action not undertaken
- n/a Action not applicable

8. Action Plan

A stormwater management Action Plan has been prepared, based on the outcomes of the options evaluation (refer Chapter 7), to clearly link priority management options with associated stormwater issues and provide the mechanisms to achieve the objectives defined for the Cooks River. The Action Plan (*Table 8.1*) prioritises actions, assigns responsibilities, specifies performance indicators, and provides the working document for ongoing stormwater management. To assist in the interpretation of *Table 8.1*, each of the columns are explained below.

Strategy Column: To ensure consistency with existing Action Plans prepared for the Cooks River and with individual Council's Management Plans, practical strategies have been identified to address the causes of each stormwater issue. The strategy column in Table 8.1 provides a grouping of stormwater management actions which assists in identifying priorities for implementation.

Level Column: Actions have been identified as either "Level 1" or "Level 2". Actions which can be implemented without further investigation have been classified as Level 1 actions. Actions which require further investigation to determine feasibility, ownership, and cost sharing arrangements in more detail have been classified as Level 2 actions. Level 2 actions will be further investigated within the first year of the Plan to confirm their feasibility or to identify an alternative action to achieve the same outcome.

Action Column: Actions listed here are the priority management options assessed in *Table 7.1*. Actions can be linked to *Table 7.1* and *Tables 9.1-9.16* by the rank number as listed in column six. Many actions identified for a particular issue may also address other issues. For example, an action which aims to prevent sediment from roads entering the waterways will also prevent toxicants which bind to the sediments from entering the waterways.

Responsibility and Waterway Columns: The stormwater manager responsible for the implementation of each action and the sub-catchment to be affected by the action is identified in these two columns. The abbreviations used are as for *Table 7.1*(refer to *Section 7.3*).

Rank Column: Each option has been assessed and ranked according to the methodology detailed in *Section 7.3.* A ranking of 1 is considered the most favourable and will be considered of higher priority for implementation. This ranking can be used to link the actions in this table with those in *Table 7.1.*

Performance Indicator:	A performance indicator is identified to enable evaluation of the success of each of the actions within the plan. The Association of Councils recognises the importance of monitoring the success of individual actions as well as the overall success of the Plan.

8.1 Continual Improvement

The Action Plan is not intended to be static, and will be subject to continual improvement as new information becomes available and priorities change. *Figure 18* illustrates the framework by which the Action Plan is to be implemented and its performance evaluated. The development of a management framework, a supporting investment program, and provision for ongoing consultation with stakeholders, form the components of the Implementation Program detailed in later Chapters of this report.

It is proposed that minor amendments would be made to the Action Plan and the Council Implementation Programs on an annual basis, immediately prior to preparation of Council Management Plans. These changes would reflect the annual results of the monitoring and evaluation program, further investigations and feasibility studies, and budgeting opportunities for the coming year.

The Stormwater Management Plan should be revised with more significant amendments every 4-5 years to enable updating of the short-term objectives for stormwater management, a review of the stormwater issues, and consequent priority actions.

Figure 18 Framework for Management, Implementation and Evaluation of the Action Plan.

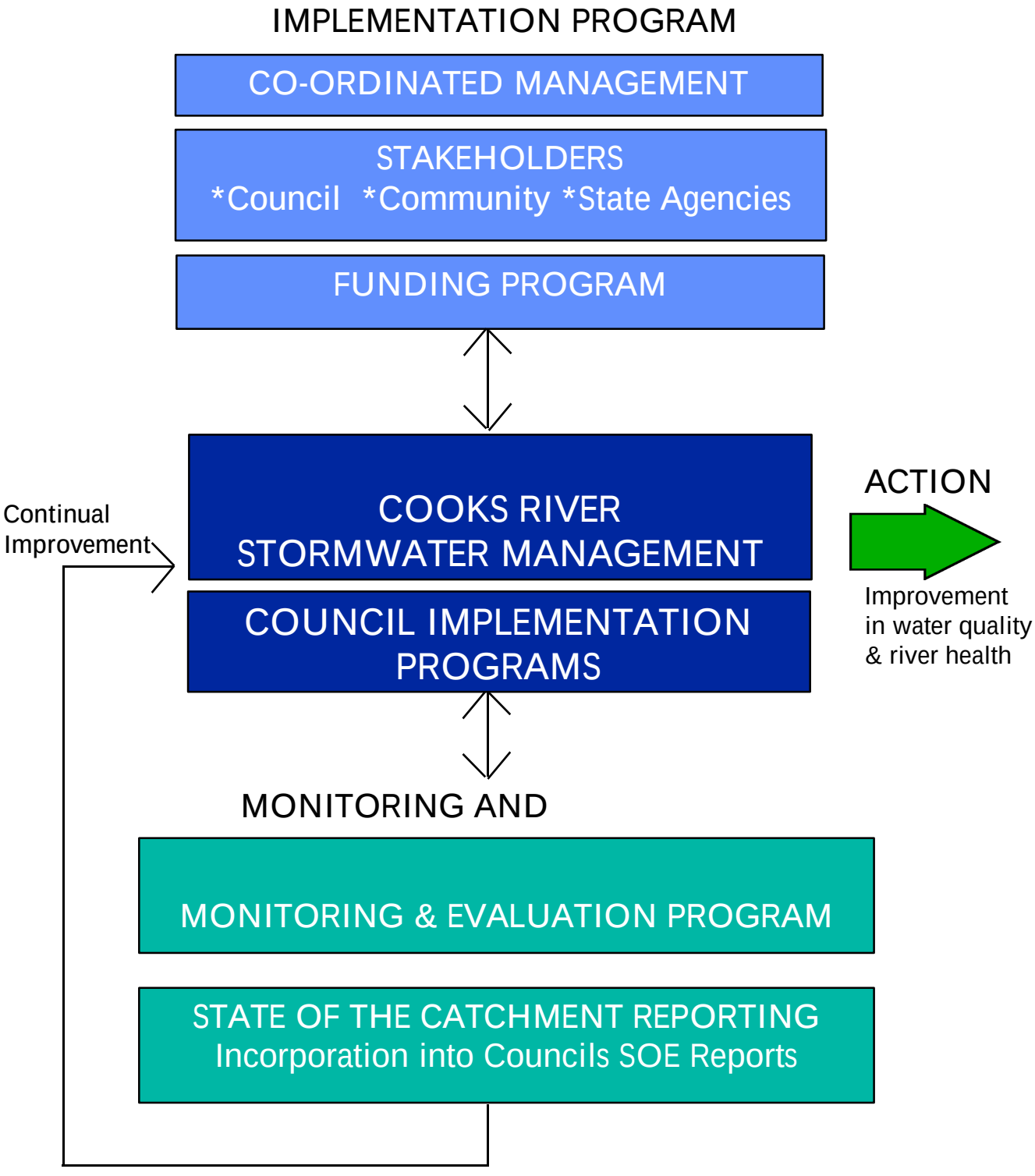


Table 8.1:

LITTER	ISSUE: High volumes of litter within the Cooks River, impacting on visual amenity and habitat values, possibly due to ineffective waste management, littering in residential, industrial and commercial areas, along roads and in parks.					
Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
1. To prevent general littering and raise the awareness of the link between the backyard and the river.	1	1.1 Develop an education and awareness program in schools, in cooperation with the Department of Education to link littering with impacts on the waterway.	ALL-C/EDDept	ALL	2	When surveyed, more people understand how their actions affect River health and have changed their polluting practices.
	1	1.2 Develop and construct educational signs in public areas, in particular along waterways adjacent to stormwater control facilities, to provide information and feedback on the status and improvements in stormwater quality and projects being undertaken to improve water quality eg. signs next to a litter boom can report on the volume of litter collected each month and show improvements over time.	ALL-C	ALL	6	
	1	1.3 Support anti-Litter education campaigns at a local level through signage and local education. eg. Clean -Up Australia Day, The Drain is Just for Rain, Streets to rivers project, Cooks River Valley Association garbage and gutters street clean up projects.	ALL- C	ALL	57	
	1	1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	ALL	ALL	58	
2. To prevent dumping of waste.	1	2.1 Support EPA "dob in a dumper" hotline through advertising within Cooks River catchment.	ALL - C and EPA	ALL	60	Reduction in the number of dumping incidents.
	1	2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	ALL	ALL	115	
3. To provide an effect waste management service.	1	3.1 Influence State Government to introduce legislation to require manufacturers to reduce packaging and provide return fees for recyclables (for example, container deposits, and waste oil).	ALL - C	ALL	14	Reduction in the volume of recyclable material found in waterways.
	1	3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	ALL	ALL	79	
	1	3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	RTA, Rail, SWC ALL	ALL	155	
4. To prevent litter generated in commercial and industrial areas entering the waterways.	1	4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	ALL	ALL	29	Reduction in litter in waterways.
	1	4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	ALL	ALL	36	

	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
	1	4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	ALL	ALL	154	
	2	4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	ALL	ALL	158	
	2	4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	All, RTA	ALL	156	
5. To effectively Manage litter in parks to prevent litter entering the waterways.	1	5.1 Trial management options for litter in parks along the Cooks River foreshore by removing bins and providing signage "Thank You for caring for the park and the Cooks River". In some areas providing additional bin facilities is another. Monitor success of the trial bin project and implement appropriate strategy for ALL parks along the Cooks River foreshore.	MAR, ROC, CANT	ALL	28	Reduction in volume of litter observed in park areas.
	1	5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	ALL	ALL	61	
6. To remove litter that has entered the waterways by maintaining and improving existing stormwater structures.	1	6.1 Maintain the existing pollutec pollutant trap at the park near Belmore Rugby League field.	CANT	CO	62	Litter traps are functioning.
	1	6.2 Maintain existing trash rack at Muir Rd, Chullora.	BANK	UP	108	
	1	6.3 Investigate improvements to litter boom along Cooks River at Fifth Avenue Campsie with Cooks River Valley Association to improve the performance of the boom.	SWC	CO	109	
	1	6.4 Maintain existing GPT at Orissa Drain, Fifth Avenue Campsie.	SWC	CO	125	
	1	6.5 Maintain existing GPT and drainage pumping station/detention basin at the Brickpit, Railway Road, Sydenham.	SWC	MA	127	
	1	6.6 Maintain existing trash rack at Mackey Park, Marrickville.	SWC	MA	141	
	1	6.7 Maintain existing trash rack at Cup & Saucer Creek, Canterbury.	SWC	CS	150	
	1	6.8 Maintain existing GPT at Wolli Creek, Kingsgrove.	SWC	WO	151	
7. To provide litter collection structures at identified hot spot areas.	1	7.1 Require the incorporation of litter & erosion controls into redevelopment of the site upstream of King Georges Rd, Hurstville.	HUR	WO	85	Structures installed reduce "hot spot" litter problems.
	2	7.2 Investigate feasibility of installing a gross pollutant interceptor on pipe outlet near Thornley St, Marrickville.	MAR	MA	86	
	2	7.3 Provide minor gross pollutant traps on pipe outlets to Bardwell Creek near Bardwell Rd.	ROC	BA	87	
	2	7.4 Provide buffer strips behind embankment walls of channel at Rudd Park, Belfield where necessary.	CANT	Omaha	96	

Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
	2	7.5 Retrofit pit litter baskets at selected sites Hercules St area, Dulwich Hill.	MAR	CO	97	
	2	7.6 Install pit litter baskets in area near the Australian Golf Club where appropriate.	RAN	AC	98	
	2	7.7 Provide coarse trash rack along Bardwell Creek near Ellerslie Rd, Bexley North to protect the downstream bushland.	ROC	BA	105	
	1	7.8 Install proposed pollutant trap at Tennyson St, Dulwich Hill subcatchment outlet.	MAR	MA	110	
	1	7.9 Maintain GPT and construct wetland in redevelopment of SRA land at Chullora Rail Workshops and provide maintenance.	SWC/BLG	UC	118	
	1	7.10 Install and maintain proposed GPT at Tasker Park, Campsie.	CANT	CO	128	
	2	7.11 Provide gross pollutant interceptor/GPT near pipe outlet of Mascot West SWS or further upstream where accessible for maintenance.	SWC	AC	131	
	2	7.12 Provide gross pollutant interceptor near pipe outlet of Munni SWS upstream of proposed dechannelistation works.	SWC	AC	132	
	2	7.13 Provide pit litter baskets at selected locations in Campsie industrial area within Cup and Saucer Creek catchment.	CANT	CS	145	
	2	7.14 Investigate provision of Litter baskets at Cosgrove Road/ Madeline St industrial area.	STRA	UC	134	
	2	7.15 Retrofit litter baskets/silt traps at selected pits in Orissa St subcatchment, Campsie.	CANT	Orissa	135	
	2	7.16 Investigate provision of offline GPT or wet pond system on vacant land at bend in Cooks River adjacent to Dean Reserve, Strathfield.	SWC/STRA	UC	136	
	2	7.17 Provide GPT/wetland downstream of Hume Highway along Greenacre Park SWS.	SWC/BANK	UC	137	
	2	7.18 Provide pit litter baskets at selected locations within Bardwell Creek catchment.	ROC	BA	140	
	2	7.19 Provide gross pollutant trap/interceptor at a suitable and accessible location upstream of Botany Rd SWS pipe end.	SWC	AC	142	
	2	7.20 Provide gross pollutant interceptors at pipe outlets (approx. 3) to Cup and Saucer Creek at industrial area near Alfred St, Campsie.	SWC/CANT	CS	143	
	2	7.21 Install gross pollutant traps before pipe outlets (approx. 2) to Cooks River at HJ Mahoney Memorial Reserve, Marrickville South.	MAR	CO	139	
	2	7.22 Install gross pollutant traps before pipe outlets (approx. 3) to Cooks River at Steel Park, Marrickville South.	MAR	CO	152	
	2	7.23 Determine feasibility of providing gross pollutant traps on pipe outlets (approx. 3) to Cox's Creek near King Georges Rd, Greenacre or combined (wetland) facility in the parkland on the northern side of the canal.	SWC	CX	152	

NUTRIENTS & BACTERIA		ISSUE: Elevated levels of nitrogen and phosphorus which can lead to algal blooms, increased weed growth, impacts on aquatic plants and animals and human health. Possibly due to discharge of detergents, excess fertiliser use, animal droppings, and sewerage overflows.				
Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
8. To manage nutrient runoff resulting from detergent usage in residential, commercial and industrial areas.	1	8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	ALL	ALL	15	Reduction in nutrient levels in waterways.
	1	8.2 Influence state government to investigate alternatives to phosphorus use in detergents.	ALL-C	ALL	26	
	1	8.3 Educate the community to prevent car washing on the street. In residential areas, where there is no alternative, provide an incentive by negotiating with local car washing places for first visit free coupons to encourage use of carwash centres.	ALL - C	ALL	73	
	1	8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	ALL	ALL	111	
	2	8.5 Provide public car wash areas in existing high density residential areas which drain and are connected to sewer or a suitable alternative. Also provide signs to educate people about carwashing in the streets.	MAR, CANT BANK,	ALL	119	
	1	8.6 Investigate options to implement requirement for inspection of sewer and stormwater connections into certification required for all residential and commercial property sales.	SWC	ALL	25	
9. To reduce nutrient and bacteria runoff from dog droppings in public areas.	1	9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	ALL	ALL	22	Reduction in dog droppings observed in parks.
	2	9.2 Investigate the feasibility of introducing dung beetles to decompose dog droppings in council Park areas based on outcomes of Strathfield council trial.	ALL-C	ALL	45	
10. To reduce organic matter entering the stormwater system.	1	10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	ALL	ALL	53	Reduction in organic material observed in waterways.
	1	10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	ALL	ALL	59	
11. To reduce nutrient inputs resulting from fertiliser use.	2	11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	ALL	ALL	46	Changed fertiliser use practices.
	1	11.2 Educate residents about over-fertilisation by developing and distributing an information brochure.	ALL-C	ALL	148	
	1	11.3 Incorporate in planning controls a requirement for future Golf Course developments to incorporate nutrient management controls.	ALL-C	ALL	42	

Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
12. To address algal blooms in waterways.	1	12.1 Identify appropriate response procedures to manage blue green algal blooms.	ALL- C	ALL	20	Reduction of algal blooms.
13. To remove nutrients that have escaped source controls and entered the waterways.	2	13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	ALL (not Ash)	ALL	34	
	2	13.2 Investigate provision of constructing an urban stream at Strathfield Golf Course/Freshwater Park.	STRA	UC	91	
	2	13.3 Construct wetland along Bardwell Creek downstream of Ellierslie Road and rehabilitate riparian zone where possible through Shepard Reserve and Favell Picnic Area.	ROC	BA	95	
	2	13.4 Construct small wetland above the tidal limit at Heynes Reserve, Canterbury to receive flows from Cup and Saucer canal.	SWC/CANT	CS	101	
	2	13.5 Investigate feasibility of installing a constructed wetland in Cooke Park downstream of Madeline Street, or upstream of Madeline Street in Begnell Park.	SWC/STRA	CX	102	
	2	13.6 Construct offline wetlands or pond system adjacent to Muddy Creek in White Oak Reserve.	SWC/ROC	MU	103	
	2	13.7 Construct offline wetland upstream of tidal limit on Omaha Canal.	SWC/CANT	Omaha	104	
	1	13.8 Install backwash storage tanks and dispose of backwash from Roselands and Canterbury Pools to sewer.	CANT	CO	106	
	2	13.9 Replace concrete lined canal through Hughes Park, Canterbury with linear wetland or pool/riffle sequences along this reach of Cup and Saucer Creek.	SWC	CS	116	
	2	13.10 Investigate opportunity to develop additional wetland as part of the proposed NPWS regional park in lower Wolli Creek area.	ROC	WO	123	
	2	13.11 Trial the creation of wetlands in the upper sections of Alexandra Canal as proposed in Alexandra Canal Water Environment Plan.	SWC	AC	144	
TOXICANTS		ISSUE: High concentrations of heavy metals, oils and grease, and pesticides which presents a health risk to water way users, and aquatic ecosystems. Possibly due to industrial discharges, runoff from residential areas, roads and railways, landfills leachate and weed spraying along drainage lines.				
Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
14. To raise awareness of business managers and prevent the discharge of toxicants by industry.	1	14.1 Lobby EPA to audit all licensed premises in the catchment.	ALL- C, EPA	ALL	21	When surveyed, more businesses and industry understand how their actions affect water quality and have changed their polluting practices.
	1	14.2 Education/Training/Auditing of small industrial premises and businesses through expansion of past solutions to pollution, education and auditing programs. Target metal premises, motor vehicle repairers and chemical manufacturers as a priority.	ALL-C	ALL	84	
Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator

	1	14.3 Initiate increased auditing of non-EPA licensed industrial and commercial premises by Council officers. As a priority, investigate industrial area upstream of the high metal concentrations within Cup and Saucer Creek near Kingsgrove Road.	ALL-C, EPA, CANT	ALL	124	
	1	14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	All	ALL	77	
	1	14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	ALL	ALL	81	
15. To manage weeds to reduce toxicants resulting from weed spraying entering waterways.	1	15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	ALL, SWC, Rail, RTA	ALL	11	Reduction of weeds in drainage lines.
	1	15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	ALL	ALL	75	
16. To prevent toxicants in landfill leachate contaminating waterways.	2	16.1 Investigate need for site remediation and leachate control at the former brick pit at Harp St, Campsie.	CANT	CS	12	Identified landfills are remediated to prevent migration of leachate off-site.
	1	16.2 Remediate Tempe Reserve landfill area to prevent off site leachate of contaminants.	MAR	AC	63	
MANAGERIAL		Issue: Inconsistent management of stormwater, uncertainty of responsibility and lack of funding leading to inaction. Possibly due to the large number of stormwater managers, no co-ordination body and lack of public awareness.				
Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
17. To raise awareness of stormwater management in the community.	1	17.1 Investigate and develop opportunities for community, schools and businesses which are part of the problem to become part of the solution by becoming involved in stormwater management. For example, through on ground works, green industry awards, bush regeneration/tree planting, community bird watching programs, school problem solving, curriculum.	ALL-C	ALL	50	When surveyed, more businesses and community understand their responsibilities with regard to stormwater management.
	1	17.2 Implement greater use of ethnic media to reach non-English speaking community. Develop information sheets and disseminate through community centres and schools.	ALL-C	ALL	51	
	1	17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	ALL, SWC	ALL	44	
18. To use consistent planning mechanisms across the catchment to prevent contamination of stormwater.	1	18.1 Councils to incorporate detention basins, rainwater collection tanks (where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	ALL	ALL	7	Consistent planning policies implemented throughout Councils in the catchment.
	1	18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	ALL	ALL	9	
Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator

	1	18.3 State agencies to ensure stormwater management policies for developments (such as the M5 Motorway, Rail Yard redevelopment and Airport expansions etc.) are consistent with Council planning policies and controls for stormwater management.	RTA, SWC, Rail, DOT	ALL	18	
19. To define stormwater management responsibilities.	1	19.1 Identify and map ownership of all government land within the Cooks River Catchment and agree responsibilities between land managers in the catchment.	ALL-C, RTA, SWC, Rail, DOT, CMC, WA, CRCMC, EPA	ALL	3	Management responsibilities defined.
	1	19.2 Define and agree notes and responsibilities for stormwater and catchment management within Cooks River based on Action No. 90.	ALL-C, RTA, SWC, Rail, DOT, CMC, WA, CRCMC, EPA	ALL	17	
20. Increase communications between stormwater managers.	1	20.1 Integrate Council's knowledge and information through catchment wide water quality monitoring and reporting. Evaluate data to determine strategic responses to problems identified by the monitoring program.	ALL - C	ALL	89	Stormwater managers effectively communicating.
	1	20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	ALL	ALL	52	
SUSPENDED SOLIDS		Issue: Elevated suspended solids and turbidity levels affecting the health of the ecosystem and resulting in brown and murky water, sediment deposition on which weeds may grow, and obstruction to stormwater controls. Possibly due to inputs from construction sites, removal of natural vegetation, poor industrial and commercial practices.				
Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
21. To improve industrial/commercial practices to minimise sedimentation.	1	21.1 Educate occupiers of commercial premises and residences about not hosing down footpath areas.	ALL-C	ALL	83	Reduction in sediment loads.
	1	21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	ALL, EPA	ALL	92	
22. To manage sediment in stormwater runoff from construction sites.	1	22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	ALL	ALL	37	Sediment concentrations in adjacent water are unchanged from background during construction period.
	1	22.2 Educate construction contractors on appropriate sediment controls based on best practice guidelines (eg. signs on sediment fences).	ALL-C	ALL	90	

Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
	1	22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	ALL	ALL	113	
23. To prevent sediments that have escaped source control from entering the waterway.	1	23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	ALL, RTA, SWC	ALL	151	Sediment removal structures are functioning.
	2	23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	ALL, RTA, SWC	ALL	138	
	1	23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	ALL, RTA	ALL	157	
	1	23.4 Maintain existing detention pit/drainage pumping station at Carrington Road, Marrickville.	SWC	CO	120	
24. To address sedimentation in hot spot areas.	1	24.1 Investigate and install erosion controls for development immediately upstream of drainage channel at eastern boundary of Rookwood Cemetery and for the channel itself.	AUB & BANK	UC	33	Structures installed reduce "hotspot" sediment loads.
	1	24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	SWC, ALL	CO	40	
	1	24.3 Refill eroded ground behind embankment along Cooks River downstream of Fore St, Earlwood.	CANT	CS	41	
	1	24.4 Investigate cause of sludge buildup at Mackay Park, Marrickville.	MAR	MA	47	
	2	24.5 Provide buffer strips along drainage line to Bardwell Creek through Jubilee Park and Bardwell Park.	ROC	BA	64	
	1	24.6 Develop erosion & sediment control plan for Council's Waste Transfer Station, St Peters.	SWC	AC	76	
	1	24.7 Develop erosion & sediment control plan for the exposed soil areas of Enfield Marshalling Yards. Investigate opportunities to provide buffer strips and sediment basins at appropriate locations.	Rail	UC	78	
	2	24.8 Develop erosion & sediment control plan for Cooks River Goods Yards, Sydenham.	Rail, MAR	AC	93	
	2	24.9 Investigate appropriate bank remediation works along Bardwell Creek in conjunction with revegetation upstream of Bardwell Rd, Bardwell Park.	ROC	BA	94	
	1	24.10 Develop sediment control plan for Chullora Rail Workshops to control runoff from exposed surfaces. Investigate opportunity for buffer strips and sediment basins at appropriate locations.	Rail	UC	99	

Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
	1	24.11 Develop erosion & sediment control plan for Eveleigh Railway Workshops.	Rail	AC	100	
	2	24.12 Provide bank stabilisation along the Cooks River between Illawarra Rd to Marsh St, Arncliffe.	CANT/MAR	CO	107	
	2	24.13 Provide bank stabilisation, in association with revegetation works, along the Cooks River between Church St to Ford Ave, Hurlstone Park.	CANT/MAR	CO	112	
	2	24.14 Provide stream remediation/bank stabilisation along Cooks River downstream of Chullora Rail Workshops to Strathfield Golf Course.	AUB	UC	117	
	2	24.15 Install detention basin at Chullora Railway Workshops.	BANK	UC	133	
	2	24.16 Install drainage pumping station /detention pit and silt screen at Mary Street, St Peters.	MAR	MA	149	
HABITAT LOSS AND RIVER HEALTH		Issue: River ecosystem of very poor health and low biodiversity due to changes to habitat and removal of natural processes.				
Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Measure
25. Recreate riparian and bushland habitats to act as a buffer for stormwater.	1	25.1 Incorporate setbacks of at least 10m from creek lines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	ALL	ALL	4	The area of native riparian vegetation is increased.
	1	25.2 Develop a catchment policy for landscaping along foreshore and waterways using native species, based on existing reports and incorporate into Council planning controls.	ALL-C	ALL	27	
	2	25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	ALL	ALL	10	
	1	25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	ALL	ALL	24	
26. Protect remnant foreshore vegetation and natural waterways.	1	26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	ALL	ALL	8	Existing remnants and natural channels remain protected.
	1	26.2 Protect Freshwater Creek during redevelopment of the Chullora Site through appropriate planning controls and design. Continue to liaise with Bankstown Bushland Society in this process.	BANK & Rail	UC	66	
Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Measure
27. Protect existing wetlands and intertidal zones from the impacts of stormwater.	1	27.1 Incorporate Wolli Creek Mangroves and Saltmarsh through planning policies and bushcare regeneration programs. Investigate measures to minimise sedimentation and disturbance from railways.	CANT & ROC & Rail	WO	67	Existing wetland are protected.
	1	27.2 Protect the Third Ave Remnant bushland in Campsie, through incorporation in planning policies.	CANT & SWC & RTA	CO	68	
	1	27.3 Protection of remnant vegetation within Marrickville Foreshore Reserves.	MAR	LC	69	

Strategy	Level	Action	Responsibility	Waterway	Rank	Performance Indicator
	1	27.4 Protection of Cooks River Clay Plains Scrub Forest within proposed redevelopment site at Rail Yards.	Rail	LC	71	
	1	27.5 Undertake bush regeneration and protection works on remnant vegetation along Wolli Creek from Bexley Road, eastwards.	CANT / ROC	UC	72	
28. Recreate aquatic habitats suitable for native waterbirds and fish.	1	28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	ALL	ALL	5	An increase in the length of "natural" channel.
	2	28.2 Dechannelise the concrete drain between the head of Alexandra Canal and Green Square (lower Sheas Creek) as proposed in Alexandra Canal Water Management Plan.	SWC	AC	13	
	1	28.3 Investigate naturalising concrete channel by placing rock and planting native vegetation at Chain of Ponds reserve area, where space allows.	SWC/STRA	UC	48	
	1	28.4 Prepare a Mangrove Management Plan to identify areas for regeneration either via natural colonisation or habitat generation and areas where mangroves are removed to prevent flooding. Comply with NSW State Rivers and Estuaries Policy.	ROC, BOT, MAR, SSC, CANT, Fisheries	ALL	35	
	1	28.5 Negotiate with DLWC to replace sheet piling along Cooks River, between the Undercliff Bridge and the footbridge at Flinders Road with more natural bank stabilisation where possible.	DLWC, MAR, CANT	LC	49	
	1	28.6 Investigate river bank stabilisation works and create a more natural bank and riparian zone at Freshwater Park.	STRA	UC	56	
	1	28.7 Replace concrete embankment along Muddy Creek near White Oak Reserve with rock/vegetation and link to the adjacent reserve.	SWC	MU	80	
	2	28.8 Negotiate with Department of Land and Water Conservation to selectively replace steel sheet piling along Cooks River banks between Church St, Canterbury and Flinders Rd, using rock embankment/natural vegetation, following a feasibility study.	DLWC, MAR, CANT	LC	121	
	1	28.9 Naturalise concrete stormwater channel through Parry Park by placing rock and planting native vegetation.	SWC	CX	130	
	1	28.10 Narrow Alexandra Canal with islands and bank extensions from Canal Rd as proposed in Alexandra Canal Water Management Plan.	SWC	AC	146	
	1	28.11 Dechannel 250m section of stormwater channel between the head of Alexandra Canal and Sydney Park as proposed in Alexandra Canal Water Management Plan.	SWC	AC	147	

8.2 Monitoring and Evaluation Program

The Association of Councils is committed to undertaking a "whole of catchment" approach to monitoring progress towards the stormwater management objectives identified in Chapter 5. The monitoring and evaluation of the Stormwater Management Plan will involve the following key components:

- an action evaluation program to determine the success of individual actions in the Action Plan; and
- an ongoing water quality monitoring program undertaken consistently across the whole catchment;
- a river health monitoring program undertaken in association with the community;
- a "State of the Catchment" reporting process.

Key details of these programs are provided in the sections below. The monitoring programs have been scoped in accordance with principles outlined in the EPA's *Draft Council Handbook for Managing Urban Stormwater* (1997). Further detail in the design of these monitoring programs will be undertaken as the first step in their implementation.

8.2.1 Stormwater Management Action Plan Evaluation Program

The Councils of the Cooks River catchment recognise the importance of monitoring the performance of each action in addressing the associated stormwater issue. For example, localised stormwater quality monitoring will be conducted at hotspot locations to determine the success of structural solutions in addressing specific stormwater management issues.

Performance indicators have been identified in the Action Plan (*Table 8.1*) as the basis for assessment of each action. The monitoring of the performance of each action will be incorporated into the implementation of the action.

The outcomes of the monitoring undertaken for each action or group of actions will determine which actions are effective in addressing the stormwater issue. The results of the action evaluation will also identify actions which require modification to improve their effectiveness.

8.2.2 Cooks River Catchment Water Quality Monitoring Program

Aim

The water quality monitoring program aims to measure the effectiveness of the Plan toward achieving stormwater management objectives 5, 6, 7, 8, and 9 (refer *Table 5.1*). It is intended that this water quality monitoring program be consistently undertaken over a long time period so that real trends in water quality throughout the Cooks River can be measured. A "whole of catchment" approach to monitoring water

quality in the Cooks River and its tributaries will provide a better understanding of the stormwater issues and ensure the best use of the limited funds available. This monitoring program is not intended to measure the success of individual stormwater management actions. The evaluation of implemented actions is addressed in *Section 8.2.1* above.

This 'whole of catchment' water quality program would be supplemented by community monitoring programs at know hotspot locations. These community programs will be undertaken in association with the education programs identified in the Action Plan and will involve school and community groups.

It should be noted that this water quality monitoring program is not specific to stormwater quality as all impacts on water quality will be measured. Nevertheless, such a water quality monitoring program is essential to assess the effectiveness of the Plan against stormwater management objectives identified in *Chapter 5*. The evaluation of the result must be undertaken in context of other major inputs such as sewer overflows and contaminated sediment, groundwater inputs, and tidal influences

Site Selection

It is proposed that water quality monitoring be undertaken at 11 sites, one site within each sub-catchment of the Cooks River (refer *Figure 5*). The sites should be located towards the discharge point of the sub-catchment with regard to:

- safe access for sample collection;
- location of past monitoring point, to maximise use of existing data;
- tidal limits, to avoid dilution; and
- ability to measure flow.

Suggested locations for future monitoring sites are identified on *Figure 5*.

Monitoring Frequency

The monitoring frequency will be determined by the statistical design of the sampling program during the first stage of implementation. It is recommended that three dry weather sample be collected at defined times every year, as well as three event based (wet weather) samples each year. It will be important for the samples to be collected at all eleven sampling sites on the same day. For those sample sites located in the tidal zone, samples should be collected on the outgoing tide.

Water Quality Parameters

To assess water quality of the Cooks River against the objectives for stormwater management identified in *Chapter 5* the following measures are required:

- Assessment of water quality against ANZECC guidelines (ANZECC, 1992) for protection of aquatic ecosystems in all tidal areas (marine waters guidelines) and freshwater natural channels (fresh waters guidelines).

- Assessment of water quality against ANZECC guidelines for primary contact (long term) recreation in tidal areas and against secondary contact (short term) recreation in all waterways.
- Assessment of the visual amenity of the waterway in regard to reduced suspended solid levels and visible litter.

Therefore, water quality parameters have been selected to enable measurement against guidelines for protection of marine and freshwater ecosystems, secondary and primary contact recreation, and visual amenity depending on the waterway. *Table 8.2* identifies the key water quality parameters required to enable assessment against the above objectives. The most sensitive guideline for each parameter is also provided to assist in scoping the methodology detection limits for sample analysis. As the water quality objectives vary for tidal areas, natural channels and piped channels within the Cooks River (refer *Figure 7*), the water quality will be evaluated accordingly. However, it is recommended that all the parameters identified in *Table 8.2* be analysed in each water quality sample to assist in understanding pollution sources and inputs from upstream sub-catchment.

In addition to the parameters in *Table 8.2*, each sampling event will require a description of the climatic conditions (rainfall event, duration and amount) in the 10 days prior to sampling.

Table 8.2: Proposed Water Quality Parameters for Cooks River

Parameter	Proposed Measure for each Parameter based on the most Stringent ANZECC (1992)Guideline* or other appropriate measure. (Protection of Aquatic Ecosystems and & Primary Contact Recreation)
OBSERVED PARAMETERS	
Litter (estimate number and type of litter items visible)	Number of litter items per square metre quadrant.
Water Clarity/ Colour	Visual amenity guidelines
Flow Rate estimate (m3/s)	Appropriate flow gauging methodology
PHYSICO-CHEMICAL INDICATORS	
Total Phosphorous (ug/L)	less than 50
Total Nitrogen (mg/L)	less than 0.50
Faecal Coliforms (CFU/100mL)	less than 150 (median)
Dissolved Oxygen (mg/L or % saturation)	more than 6 mg/l or 80-90%
Suspended Solids (Turbidity NTU)	less than 10% change /6 NTU
Chlorophyll-a (ug/L)	10
pH	6.5 - 8.5
TOXICANTS (ug/L)	
Cadmium	2
Copper	5
Lead	5
Zinc	50
Oil and Grease	Visible Oil

* Note: These criteria are provided to assist in identification of the measure, methodology and detection limits by indicating the most sensitive criteria. The sample results should be compared to appropriate guidelines as detailed in the *Evaluation and Reporting of Results* section below.

Sampling Method and Analysis

The methodology used to collect the water quality samples should be standardised for all samples and follow established techniques for grab sampling (EPA, 1995). Grab samples should be taken approximately 30 centimetres below the surface where possible so as to not collect surface film and as far away from the waters edge as practicable. Depth integrated sampling could be undertaken for the lower reaches of the Cooks River. Three replicate sample should be taken at each location.

Analysis of water samples for the identified parameters should be undertaken by a NATA accredited laboratory to ensure quality control and consistent analytical methodology. Water samples should be analysed as soon as possible after sampling.

Evaluation and Reporting of Results

The results of water quality sampling are to be recorded on a Standard Record Form and imputed into a computer database. The evaluation water quality sampling results against the objectives of the water quality program requires a comparison against ANZECC (1992) guidelines. As indicated in *Table 8.3*, the guidelines for evaluation vary depending on the waterway type. These waterway boundaries are mapped in *Figure 7*.

Table 8.3: Evaluation of Water Quality Results

Waterway in which Sample was taken	Guidelines to be Evaluated Against ANZECC (1992)
Close to river mouth in the lower section of the Cooks River	▪ ANZECC Guidelines for Human Consumers of Fish, Crustaceans and Shellfish. ▪ ANZECC Guidelines for Protection of Marine Ecosystems ▪ ANZECC Guidelines for Primary & Secondary Contact Recreation ▪ Visual Amenity Guidelines
Tidal waterways	▪ ANZECC Guidelines for Protection of Marine Ecosystems ▪ ANZECC Guidelines for Primary & Secondary Contact Recreation ▪ Visual Amenity Guidelines
Non-tidal Natural Channels	▪ ANZECC Guidelines for Protection of Freshwater Ecosystems ▪ ANZECC Guidelines for Secondary Contact Recreation ▪ Visual Amenity Guidelines
Non-tidal Artificial Channels	▪ ANZECC Guidelines for Secondary Contact Recreation ▪ Visual Amenity Guidelines

To provide a measure against achievement of the short term objectives for stormwater management, the number of times the criteria are met should be recorded for each sub-catchment and mapped as demonstrated in Figure 7.

A comprehensive annual report should be prepared providing the following information:

- objectives of the water quality monitoring program;
- sampling method and limitations;
- map indicating sampling locations and results;
- results of water quality monitoring and evaluation against guidelines;
- evaluation against objectives for stormwater management;
- identification of stormwater pollution issues; and
- recommendations for future stormwater management and evaluation.

In the evaluation of the effectiveness of the Plan, the report must also discuss relative impacts of other major inputs such as sewer overflows, contaminated sediment, groundwater inputs, and tidal influences.

Funding and Resources

The water quality monitoring program will be funded proportionally by the Councils of the Cooks River catchment on a land area basis. Many Councils within the catchment already undertake water quality monitoring and will direct their existing water quality monitoring budget towards this catchment wide monitoring program. Sydney Water, and other Government Authorities conducting water quality monitoring within the Cooks River are likely to benefit from the results and will also be asked to contribute towards this catchment wide program.

Auburn, Randwick, Kogarah and Ashfield Councils will not be required to contribute to this program as their local government areas represent areas of less than 1% of the Cooks River catchment and include no open waterways. These Councils will be involved in the “hotspot” water quality monitoring undertaken for specific management actions as detailed below.

8.2.3 River Health Monitoring Program

The River Health Monitoring Program aims to assess the effectiveness of the Plan toward achieving stormwater management objectives 1, 2, 3 & 4 (refer *Table 5.1*). It is intended the program will result in a map of the changes in ecological values of the Cooks River on an annual basis.

On an annual basis, the Association of Councils will consult with Council officers, Government Agencies, and community environment groups to update a map of ecological values of the Cooks River (refer to *Figure 6*). It is proposed that the following ecological values be identified and mapped on an annual basis.

1. Foreshore vegetation and natural waterways, including areas of:

- remnant foreshore vegetation;
- regeneration or planting of foreshore areas with native vegetation;
- natural channel;
- recreated natural channel (once concrete lined or piped);

2. Wetlands and inter-tidal zones, including areas of:

- remnant wetland;
- remnant mangrove and saltmarsh;
- recreated wetlands;
- recreated mangrove stands and inter-tidal habitats

A comparison of maps each year will enable evaluation of progress towards short term objectives for stormwater management.

Community "bird watch" groups and recreational fishermen can contribute valuable information to this river health monitoring program. Mechanisms to encourage and provide for feedback of this type of monitoring program form a component of the education programs identified in the Action Plan and will involve both school and community groups.

8.2.4 State of the Catchment Reporting

The outcomes of the above monitoring programs will be reported in a State of the Catchment Report. This information can then be incorporated into the State of the Environment Reports for each Council.

The outcomes of the monitoring programs will be used to continually improve the Stormwater Management Plan.

9. Implementation Program

An Implementation Program has been developed to specify how the Action Plan will be implemented. The Implementation Program detailed in this Chapter involves identification of:

- responsibilities and resources for stormwater management actions;
- training and awareness for Council and Agency staff;
- a mechanism for co-ordinated management of stormwater;
- opportunities for stakeholder involvement; and
- a funding program.

This Implementation Program aims to identify responsibilities for stormwater management actions and develop a co-ordinating body to drive the management of stormwater within the Cooks River catchment.

9.1 Responsibilities and Resourcing

In the development of this Stormwater Management Plan, responsibilities have been assigned for all stormwater management actions. Some actions have been identified as requiring implementation by a group of Councils and stormwater managers, some for implementation in all Council areas, and others specifically for implementation in certain areas managed by one Council or Agency. The cost of implementing the action, including capital, staff resources and maintenance costs have also been identified for each action. Note, where appropriate, cost can be offset by Councils completing the work/investigation in house.

Implementation Programs for individual Councils and key stormwater managers are provided in *Tables 9.1-9.17.* These tables identify responsibility, resourcing and tentative timeframes for implementation of the priority stormwater management actions identified in *Table 8.1.* Each of these tables has been split into part (a) and part (b). Table (a) details all the "level 1" actions, which Council has committed to implement in the short term (3-5 years). Table (b) details all the "level 2" actions which require further investigation in Year 1 to determine feasibility and confirm costs. Timeframes for implementation of these "level 2" actions will be determined following the feasibility study. As detailed in *Chapter 8*, where these actions are found to be unfeasible, alternative actions will be identified to address the stormwater issue and these will be incorporated into the Implementation Program.

The thirteen Councils of the Cooks River catchment are committed to undertaking the actions identified in the Implementation Programs detailed in Tables 9.2-9.14. This commitment will require significant funding by Councils who have many other responsibilities and limited available funds. Therefore, while the actions will be

undertaken, the timeframes for implementing the actions are considered tentative and will be reviewed on an annual basis.

The Council Implementation Programs (*Tables 9.2-9.14)* should be integrated into Council's annual Management Planning process to ensure allocation of funding and resources for implementation.

Many actions will be most effective, in a cost-benefit sense, if they are implemented on a catchment basis. These actions require co-ordination of many stormwater managers and would be best implemented by a co-ordinating body, such as the Association of Councils described in *Section 9.3*. *Table 9.1* outlines the Implementation Program for the co-ordinating body. It is intended that all Councils and Government Agencies will contribute resources and work together to implement these stormwater actions across the catchment.

Implementation Programs identifying priority stormwater management actions for individual Councils are presented in *Tables 9.2* to 9.*14.* Those actions identified for implementation in the short term, may be initiated in year one but may be ongoing. Therefore, timeframes should be interpreted as the time in which the action should commence and a starting point from which time progress should be reported on.

Costs for implementation and maintenance of proposed actions in *Tables 9.2 to 9.14*, which all Councils will implement, are proportioned according to the percentage of the catchment the Council occupies. For example, Canterbury Council occupies 24% of the catchment and therefore has been allocated 24% of the cost of implementation for the catchment.

Tables 9.15-9.17 identify actions to be implemented by key Government Agencies who have worked with Council in the development of this Stormwater Management Plan. These tables provide the basis for these Agencies to prepare individual Implementation Programs which cover all catchments within their management.

9.2 Staff Training and Awareness

A staff training program is proposed for each Council to ensure that all officers whose activities may impact on stormwater are familiar with best stormwater management practices. The program aims to raise awareness of the potential impacts of staff activities, convey the objectives of the Stormwater Management Plan and define specific responsibilities for implementation of actions within Council.

Councils will establish mechanisms for internal communications of stormwater management issues between sections and staff members. Specific procedures will be developed for key Council activities and a routine audit/educate review of implementation.

9.3 Co-ordinated Management

There are thirteen local Councils and over twenty State Government Agencies and stormwater managers throughout the catchment. The successful implementation of this Stormwater Management Plan requires a co-ordinated approach by all stormwater managers within the Cooks River. While each Council is responsible for implementing stormwater management actions (as identified in *Tables 9.2-9.14)*, a co-ordinating body is required to:

- monitor progress towards implementing the actions in the Plan;
- monitor the catchment and evaluate the success of the Plan;
- facilitate the sharing of information and programs;
- drive the implementation of the actions identified in Table 9.1; and
- continually improve the Plan.

The proposed management body to co-ordinate and drive the implementation of this Stormwater Management Plan in the short and long term is discussed below.

9.3.1 Association of Councils

In the short term, it is proposed that the Association of Councils, formed specifically to prepare this Stormwater Management Plan, continue to work together to implement the catchment wide actions within the Plan. The Association of Councils is made up of representatives from:

- Ashfield Council;
- Auburn Council;
- Bankstown Council;
- Botany Bay City Council;
- Burwood Council;
- Canterbury City Council;
- Hurstville Council;
- Kogarah Council;
- Marrickville Council;
- Randwick Council;
- Rockdale Council;
- South Sydney City Council;
- Strathfield Council;
- Sydney Water Corporation;
- Cooks River Catchment Management Committee; and

- Roads and Traffic Authority.

The role of such a Local Government Association in stormwater management is well established, with responsibilities delegated to Councils by government under the *Protection of the Environment and Operations Act*, the *Local Government Act 1993*, the *Clean Waters Act 1972,* the *Waste Minimisation and Management Act 1995*, and associated regulations. In addition, local government is committed to the environmental policies of the Federal Government such as *Ecologically Sustainable Development (ESD)* and *Agenda 21*. The key powers of Council under the Protection of Environment and Operations Act in relation to stormwater management are detailed in *Appendix F*.

The combined efforts of the thirteen Councils in the catchment has the potential to greatly enhance the implementation of actions to achieve the stormwater objectives for the Cooks River catchment. In addition, the cost of many of the actions proposed for each member of the Association of Councils is likely to be reduced through co-ordination of Council activities and dissemination of information.

The Association of Councils proposes to continue to meet on a monthly basis and will form smaller working parties to address particular actions.

9.3.2 Proposed Long-term Management

In the long term, it is considered that a "catchment authority" with the appropriate powers and resources is needed to achieve the long-term objectives for the Cooks River.

The Cooks River Catchment Management Committee was formed in 1991, under the *Catchment Management Act*, to oversee and co-ordinate natural resource management activities at a regional or entire river valley level. The committee is made up of land users and landholders within the catchment, persons with an environmental interest in the catchment, and local and state government representatives. The Cooks River Catchment Management Committee has successfully promoted and co-ordinated total catchment management programs, identified catchment needs and management strategies. The committee has prepared a comprehensive Catchment Management Strategy for the Cooks River that defines the problems and makes recommendations to reduce catchment pollution, flooding and erosion and aims to transform the river into a community asset.

However, as the existing Catchment Management Committee was established under the Catchment Management Act it is unable to generate the funds required to implement many of the stormwater management actions. The committee has little direct influence on the actions undertaken by Local Government or State Government Agencies, or for the allocation of resources, or the enforcement of stormwater management actions.

To achieve the long term objectives defined for the Cooks River, the proposed "catchment authority" must have the power to:

- negotiate effective partnerships between Councils, state agencies, and communities;

- gain funding for major works and manage contracts on behalf of Councils for joint works;
- develop and implement consistent planning controls for stormwater management; and
- independently evaluate stormwater management performance.

An example of a management structure with these powers and resources is the Upper Parramatta River Catchment Trust, which was established under the *Water Supply Authorities Act 1987*, rather than the *Catchment Management Act*. The Trustees comprise all the local Council's within the Trust's catchment area and the relevant Government Agencies. This Trust operates principally through the Council's in the catchment, which undertake most of the Trust's works and maintenance activities. Its basic operating funds are raised by rating domestic and commercial land occupiers within the catchment, the rates in this case being collected by Sydney Water on the Trust's behalf. Burton, 1995 reports that the Trust has been very successful and effectively involved local government in the catchment management process. This Trust has implemented major flood mitigation and environmental enhancement works in excess of $7.0 million in the past four years.

The Cooks River is similar to the Upper Parramatta River example in that it is a highly developed and modified catchment that requires levels of funding significantly higher than can be provided by Councils to achieve the long term objectives.

Under the *Water Supply Authorities Act*, an authority may be established by the Governor's proclamation (s6), which states the name of the authority, its area of responsibility, and the structure and constitution of its managing board. As well as separately constituted, special-purpose authorities, an existing statutory body such as a Council, may also be constituted as an Authority under the Act. Authorities may (s12) raise funds by levying rates and charges, employ staff, undertake works and provide a variety of services, enter into contracts and own buildings and properties.

On the basis of the established and highly-successful precedent of the Upper Parramatta River Catchment Trust, the establishment of a statutory Catchment Management Trust under this Act would appear to offer an attractive alternative to the establishment of a Catchment Management Trust under the *Catchment Management Act*. Such a Trust could have several advantages in that:

- there are no restrictions on the size or constitution of their managing boards, which could therefore have substantial or indeed majority representation of the Councils and Government Agencies within their area of responsibility; and
- they can be established easily and quickly by proclamation, without the need for the amendment of any legislation.

The formation of a Catchment Management Trust under the *Water Supplies Authorities Act* is the recommended management mechanism for the implementation of the Cooks River Stormwater Management Plan in the long term. The establishment of a Catchment Management Trust would allow for:

- convening of regular meetings between all stakeholders including the community;

- co-ordination and implementation of actions which are catchment-wide;
- consultation with community and environment groups;
- independent reviews of the success of the Plan;
- collection and preparation of information from Councils for an annual publication State of the Catchment Report and incorporation of outcomes in Council State of the Environment Reports;
- gaining funding for stormwater management actions;
- ensuring all Councils are implementing action plans consistently across the catchment; and
- co-ordination and implementation of water quality monitoring programs.

9.4 Stakeholder Involvement

The community stakeholders of the Cooks River Stormwater Management Plan are an influential group who's support will assist in the implementation of the Plan. Community stakeholders include the residents, neighbourhood groups, local schools, recreational users, environmental groups, Aboriginal groups and members of the business community. Many of these stakeholders contacted during the preparation of the Plan have indicated their willingness to continue their involvement in the implementation of the Stormwater Management Plan.

The implementation of many of the stormwater management actions will involve community education, liaison, participation and feedback. Community and stakeholder involvement in these actions will aim to secure their continuing support for the implementation of the Stormwater Management Plan.

9.5 Funding Program

There are significant costs associated with the implementation of the Stormwater Management Plan. Councils are committed to providing resources to implement stormwater management actions as detailed in *Section 9.1* and will seek to raise funds through sources including the Commonwealth, State and local governments, the business sector and the individual beneficiaries. Generally costs are allocated between public and private stakeholders to create a cost sharing framework according to one or more of the following principles:

- polluter pays principle, where the person who contributes to the pollution of the water body pays for the implementation of the pollution control measures on their own property, and the remediation of the pollution that is the direct result of their actions;
- beneficiary pays principle, where anyone who will receive a direct benefit from the implementation of the on ground works should contribute to the cost of those works, and

- beneficiary compensates principle, where anyone who derives an indirect benefit, such as improved recreational amenity, should contribute. The beneficiary compensates principle is appropriate where the cost of stormwater management has intangible benefits for the current and future generations of society.

The following cost sharing principles have been adopted by the Council of Australian Governments (COAG):

- the full cost of providing services to specific identifiable beneficiaries or polluters should be recovered by way of charges to them;
- costs of public benefits or impact management which are unable to be attributed and charged to specific beneficiaries or polluters should be regarded as community service obligations; and
- where costs are subsidised by government, they should be defined explicitly so that unsustainable precedents are not established.

Opportunities to increase the capacity of local Councils to secure funds for stormwater management actions are identified in the sections below.

9.5.1 Opportunities to Secure Government Funding

National Heritage Trust (NHT)

The National Heritage Trust is the Commonwealth Government's commitment over the next five years to reversing the decline in the state of Australia's environment. The National Heritage Trust brings together the Commonwealth's support for natural resource management and nature conservation, consistent with regional, state and national strategies. These strategies are to provide the broad framework for managing natural resources within the policies and programs of each State. State agencies, local governments, non-government organisations, industry and community groups are encouraged to work together to develop projects under these strategies.

The Commonwealth Government encourages community groups to responsibly manage and conserve land, vegetation, water and biological diversity in their local area. It does this by funding community groups to carry out resource management and conservation projects with one or more of the following features:

- address a high priority;
- the benefits will be shared by the local community;
- there is strong community support and contribution;
- the project will develop relevant experience knowledge and skills in the community;
- the project is consistent with an ecologically sustainable development based river, catchment or regional plan or strategy and a State, national or major river basin strategy; and

- the results of the project contribute to national objectives for the environment and sustainable resource management, and the results will be communicated to other interested individuals and organisations.

The preparation of the Stormwater Management Plan would form the basis of a regional strategy and provide the basis for an application for funds to assist in the implementation of priority works that will benefit the broader community. For funding revegetation components of the Plan a joint proposal could be made with Greening Australia (NSW), who is well placed to make applications under the National Vegetation Initiative which is a program element of the National Heritage Trust.

The Estuary Management Program

The Department of Land and Water Conservation administers and manages the State Government's Estuary Management Program, which provides financial assistance in the form of a 50 percent subsidy to implement activities that are defined in an Estuary Management Plan. The Estuary Management Manual sets out the procedures and processes to be followed for the development of an Estuary Management Plan.

Local councils are delegated the responsibility for the implementation of the Plan and are accountable for the funds. Subsidies are only granted when the Estuary Management Plan has been finalised and adopted by the councils, and its planning provisions have been incorporated in appropriate statutory plans.

9.5.2 Opportunities for Local Government to Raise Funds

Section 94 Contribution Plans

There is an opportunity for local government to use *Section 94* of the *Environmental Planning and Assessment Act* as a mechanism for sharing the costs of stormwater management activities. Section 94 is available to manage the catchment impacts of new development where the works required (for example, sedimentation basins and stormwater management works such as on-site retention ponds) are established in a Section 94 Contribution Plan and can be demonstrated to have a direct linkage to the relevant development. These contribution plans are not available for existing activities in the catchment and so cannot be retrospective.

This is effectively a cost sharing mechanism which ensures that any externalities associated with new developments are charged to the developers and users of that development. Because of this, it is necessary that the cost of works is equitably apportioned according to the costs arising from new development relative to costs associated with existing development. Land contributions to Open Space are important contributions.

Section 495 Special Rates

There is also an opportunity to use *Section 495* of the *Local Government Act* as a mechanism for cost sharing. This section of the Act enables local government to raise special rates for particular works or activities from the beneficiaries of those works or activities. This approach is consistent with the user pays approach to cost sharing for

co-financed projects with mixed public and private sector benefits. Special rates have been raised by Hornsby, Eurobodalla and Warringah Councils. The Hornsby Catchment Remediation levy was struck in 1994 and applies to the entire Hornsby Shire yielding approximately $650,000 per year.

Catchment Management Levy

The *Catchment Management Act* provides for Catchment Management Trusts to raise levies or catchment management rates to contribute towards the cost of catchment management works. This successfully establishes a cost sharing mechanism which involves resource users (property owners), local government and state agencies.

The ability to use rating powers as a cost sharing mechanism with clear accountability at a local level is one of the great attractions of a catchment levy. Such levies achieve greater equity in sharing costs across the catchment community, who are the beneficiaries of catchment management programs, and in addition have the potential advantage of attracting and leveraging additional resources from externally funded programs.

Section 30 Service Charges

Under Section 30 of the *Water Supplies Authorities Act*, declared Water Authorities (such as Sydney Water) can charge user pays fees for provision of water, sewerage and drainage services to urban and industrial developments. Service charges under Section 30 can be levied for water, sewerage, drainage, loans, development works, flood mitigation, river management and special industry services.

Stormwater Trust

The objective of the Stormwater Trust is to encourage and support improved urban stormwater quality management practices to improve the condition of the state's waterways. This is to be achieved through a combination of public education, stormwater management planning, piloting innovation and undertaking remedial actions. The Stormwater Trust's activities will promote partnerships between the private and public sectors in meeting this objective.

A number of applications for funding through the Trust have been submitted by individual Councils within the catchment. Collectively the 13 Councils have successfully applied for funding for a catchment based policy, education and auditing program to address the following issues identified during the development of the stormwater management plan:

- the lack of co-ordination between stormwater managers within the catchment;
- poor commercial and industrial environmental management practices;
- lack of understanding within the diverse residential community of the link between backyard practices and river health; and
- limited environmental awareness about the impacts of littering on waterways.

These issues became the basis for developing a series of six stormwater strategies as detailed in *Table 9.18*. The project aims to develop a multi-layered education and

auditing program for implementation simultaneously throughout the catchment. This Stormwater Trust grant will enable the funding of a number of priority actions identified in the Action Plan and highlighted in *Table 9.18* over the next year.

Table 9.18: Stormwater Strategies for Which Funding Has Been Obtained Through the Stormwater Trust 1998 Grant Application (Source Grant Application, 1998)

STRATEGY	STORMWATER ISSUE	ACTION	OUTCOME/PERFORMANCE MEASURE
1. Advise and educate property owners of the stormwater protocols and advise on practical ways to alter practices	Pollutants and toxics entering the river from industry discharges and inadequate stormwater controls	Develop a catchment wide set of stormwater protocols. Audit new and existing businesses/major landholders. Determine if pollution spikes detected in results of water quality monitoring are linked to industry discharges and stormwater practices.	Up to 1000 businesses and major land holders audited. Cleaner stormwater practices implemented by businesses and major land holders audited after 12 months. Determined if pollution spikes are associated with industry and if there has been any reduction in spikes as a result of auditing.
2. Change specific corporate practices impacting on stormwater quality and quantity.	Identifiable corporate litter such as drink bottles, chip packets and fast food packaging in waterways. Stormwater run-off from large premises.	Develop and undertake a high level approach to specific corporate businesses to alter practices.	Number of corporations which have changed practices.
3. Provide incentives for businesses to consider improving stormwater practices and publicise examples of good practice.	Same as 1.	Establish an awards program for industry building on “Solutions to pollution” program.	Number of businesses entering competition with improved stormwater practices.

STRATEGY	STORMWATER ISSUE	ACTION	OUTCOME/PERFORMANCE MEASURE
4.Raise residents awareness of need for reduction in stormwater run off and improve merits in stormwater quality; identify ways to achieve this; provide incentives for residences to consider improving practices.	Leaf litter/litter from residential premises and nature strips washing into the drains. Heavy metals in stormwater run off from certain roof types	Provide incentives, workshops and awards program for residential properties to encourage residents to : increase native planting; install rainwater tanks for garden use; plant understorey plants on nature strip to mitigate leaf litter for street trees. Awards for the most practical solutions to common stormwater problems would be given. Program would build on "Streets to Rivers" program which was run in Canterbury and Marrickville areas.	Number of residents attending workshop and taking up incentives. Number of residents maintaining improved stormwater practices after 12 months. Number of residents taking up incentives.
5. Instil in children a thorough knowledge of stormwater issues; foster a creative approach to resolving this environmental issue; raise awareness amongst families which are difficult to reach through other strategies.	Stormwater quality. Littering of waterways. Other identifiable stormwater issues	Establish and implement a problem solving based stormwater curriculum unit by a senior curriculum officer, suitable for use in all schools including: ■ an excursion to sample water quality; ■ a problem solving project to develop a "solution to pollution" approach; ■ a competition where the best ideas can be displayed, judged and possibly implemented.	Number of schools prepared to run curriculum again. Number of school children that undertook the curriculum and achieved a greater awareness of stormwater issues. School awards night for best solutions.

STRATEGY	STORMWATER ISSUE	ACTION	OUTCOME/PERFORMANCE MEASURE
6. Inform industry and residents of protocols and of the awards program.	All of the above.	Develop educational material in common languages, targeting community events. Material would include guides to alternative industry practices, appropriate building materials, indigenous vegetation suitable roadside gardens, innovative residential solutions.	Raised awareness of stormwater issues and improved stormwater practices across the community.

10. References

Australian and New Zealand Environment and Conservation Council (1992). *Australian Water Quality Guidelines for Fresh and Marine Waters,* National Water Quality Management Strategy, November 1992.

Australian Water and Coastal Studies. 1997. Muddy Creek, Scarborough Ponds and Sans Souci Drain No.1 Flood Study.

Bankstown City Council. 1998. State of the Catchments, 1997/1998, Bankstown.

Bankstown City Council. 1997. *Water Quality Improvement Program*.

Benson, D.H. and Howell, J. 1990. *Taken for Granted - The Bushland of Sydney and its Suburbs*. Royal Botanic Gardens, Sydney.

Canterbury City Council, 1998. Stormwater Management Plan Briefing Documentation.

Canterbury City Council, 1997. *State of the Environment Report*.

Central Sydney Area Health Unit. 1997. Environmental health assessment of fish and oysters from the Cooks River - heavy metals and organochlorine pesticides. *Central Sydney Area Health Unit Technical Report*

Chapman and Murphey. 1989. Soil Landscapes of the Sydney 1:100,000 Sheet.

Clouston. 1997. *Cooks River Foreshores Strategic Plan*, Volume 1, Summary Paper and Issues.

Cooks River Catchment Management Committee. (1997). *Cooks River Catchment Pollution Source Inventory*.

Cooks River Catchment Management Committee. 1993a. *Cooks River Catchment Management Strategy*.

Cooks River Catchment Management Committee. 1993b. *Cooks River Catchment Management Strategy, Background Papers*.

Cooks River Catchment Management Committee. (1996). Ecosystem health. *Annual Report to the Committee*. 122

Department of Conservation and Land Management. 1992. *Urban Erosion and Sedimentation Control*.

Department of Conservation Forests and Lands. 1987. *Control of Erosion on Construction Sites*.

Ecology Lab Pty Ltd. 1995. *An Assessment of M5 East Motorway Construction and Operational Activities of Fish and Decapods in Wetland Habitats*. Report Prepared for the Roads and Traffic Authority.

Environment Protection Authority and NSW State Stormwater Co-Ordinating Committee. 1996. *Managing Urban Stormwater - Construction Activities*.

Environment Protection Authority. 1997. *Proposed Interim Environmental Objectives for NSW Waters - Coastal Rivers*.

Environment Protection Authority. 1991. *Construction Techniques for Sediment Pollution Control*.

Environment Protection Authority. 1996. *Environmental Guidelines for Major Construction Sites. Best Practice Environmental Management Series*.

Environment Protection Authority. 1998. *Healthy Rivers Program*.

Hyder Consulting. 1997. *Alexandra Canal Water Environmental Plan*.

Land Systems Pty Ltd. 1989. *Rockdale Wetlands and Recreational Corridor Draft Plan of Management*. Prepared for Rockdale Municipal Council and the Department of Planning.

Lawson and Treloar. (1997). *Spring Street Drainage Catchment Flood Study*. Prepared for Rockdale City Council.

Manidis Roberts Pty Ltd. 1994. *M5 East Environmental Impact Statement*. Prepared for the Roads and Traffic Authority.

Marrickville Council. 1997. *State of the Environment Report*.

Muir, L. (Undated). *A History of Cooks River*.

NSW Department of Housing. 1993. *Soil and Water Management for Urban Development*.

NSW Department of Housing. 1998. *Managing Urban Stormwater - Soils and Construction*.

Public Works Department. 1985a. *Cooks River Flood Study*.

Public Works Department. 1985b. *West Kensington flooding drainage works investigation*.

Rendell, NG. (Undated). *Cooks River Catchment Erosion Report*.

Rockdale City Council. 1995. *State of the Environment Report*.

Scientific Services. 1991. *Water Quality in the Cooks River, February 1990 to June 1990*.

Sim, R (1992). *Sheas Creek Stormwater Channel - Water Quality.* Stormwater Management Southern, March 1992.

Soil Conservation Service. 1991. *Draft Total Catchment Management Action Plan, Volume 2, Task Group Reports*. Prepared for the Cooks River Total Catchment Management Committee.

South Sydney Council. 1997. *State of the Environment 1997*.

State Pollution Control Commission (1990). *Report on Water Quality.*

Sydney Water Corporation. 1994. Stormwater Monitoring Project, 1994 Annual Report. *Clean Waters Program*.

Sydney Water Corporation. 1997. *Sydney Water Annual Environment Report 1997. Environmental Indicators Monitoring Report Appendices*. Appendices E to I.

Sydney Water Corporation. 1998. *Licensing Sewerage Overflows - Environmental Impact Statements*.

Total Environment Centre. 1995a. *Final Report, Environment Condition of the Cooks River and Community Vision Strategy* (Canterbury City Council).

Total Environment Centre. 1995b. *Initial Report, Environmental Condition of the Cooks River and Community Plan*.

Total Environment Centre. 1976. *Cooks River: Environmental Survey and Landscape Design*.

Water Board. (Undated). *Cooks River Catchment Hydrology and Flooding Report*.

Water Board. 1991. *Upper Cooks River Sydney Water Corporation No. 38, Catchment Management Study, Volume 1*.

Water Board. 1992a. *Cup & Saucer Creek Stormwater Catchment Management Study, Volume 1*.

Water Board. 1992b. *Dry and Wet Weather Intensive Water Quality Sampling, Cooks River (15 January and 10 February 1992), Interpretive Report*.

Webb McKeown & Associates. 1994. *Cooks River Floodplain Management Study*. Prepared for Marrickville Council and Canterbury City Council.

Webb McKeown. 1998. *Wolli Creek, Bardwell Creek Bonnie Doon Channel and Eve Street / Cahill Park Catchments Floodplain Management Plan*. Prepared for Rockdale City Council.

Webb McKeown & Associates. 1991. *Sheas Creek Flood Study*. Prepared for Sydney Water and South Sydney City Council.

Webb McKeown & Associates. (1996). *Wolli Creek, Bardwell Creek and Bonnie Doon Channel Flood Study*.

Appendix A

Statistical Analysis
Results of the Questionnaire

Cooks River Stormwater Management Questionnaire Results

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Question A

Which problems are your biggest concern in the Cooks River Catchment?

Please rank each of the issues below out of 6, with 1 being very important and 6 being least important.

If you think a number of options are equally important please give them the same ranking

		Rating						
Environmental	Mean Rating	0	1	2	3	4	5	6
Poor water quality in waterways	1.7	2%	56%	21%	15%	3%	3%	0%
Lack of water plants and animals due to changes to habitats	3.2	8%	15%	15%	11%	23%	19%	10%
Lack of natural features, eg. tall trees, birdlife, etc	3.6	6%	16%	6%	13%	15%	29%	15%
Removal of river bank plants	3.5	8%	16%	11%	6%	24%	5%	29%
Murky/muddy waterways	3.0	5%	16%	23%	29%	5%	6%	16%
Rubbish in the waterways	1.8	8%	42%	31%	11%	3%	3%	2%

		Rating						
Health and Recreation	Mean Rating	0	1	2	3	4	5	6
Health risks associated with the recreational use of polluted waters	2.1	5%	37%	29%	18%	0%	6%	5%
Health risk of eating fish and shellfish caught in the river	2.8	3%	21%	31%	16%	6%	10%	13%
Lack of sporting, parks, open space and recreational facilities along the waterways	3.8	5%	8%	8%	15%	26%	19%	19%
Poor visual appearance of the stormwater creeks and channels.	2.8	5%	27%	13%	16%	21%	16%	2%
Loss of economic values due to pollution of water, such as decreased property values, flooding, and no fishing	4.2	8%	2%	10%	11%	18%	16%	35%
Poor management and inadequate funding of stormwater management	2.0	10%	47%	6%	15%	13%	10%	0%

Question B

What water related uses do you consider to be most important for the Cooks River?

Please rank each of the characteristics below out of 7, with 1 being very important and 7 being least important

If you think a number of options are equally important please give them the same ranking

		Rating							
	Mean Rating	0	1	2	3	4	5	6	7
Visually pleasing	2.5	8%	32%	18%	19%	8%	3%	8%	3%
Suitable for boating uses such as canoeing	3.5	6%	13%	15%	13%	21%	16%	10%	6%
Suitable for fishing	3.8	3%	19%	8%	8%	13%	21%	24%	3%
Suitable for playing and recreation along the banks and reserves	2.9	6%	13%	26%	19%	18%	10%	6%	2%
Suitable for swimming	3.6	3%	18%	15%	15%	8%	23%	15%	5%
Suitable for protection of plants and animals which live in the water.	2.3	3%	47%	13%	15%	11%	0%	11%	0%
Suitable for commercial operations (eg. oyster farming, commercial fishing)	5.3	8%	8%	5%	2%	5%	5%	13%	55%

Question C

Which of the following statements best represents your view on the present condition of the waterways in the Cooks River Catchment?

Please tick 1 box only

The Cooks River is no longer a river, rather an urban runoff drain	46	65%
A degraded environment providing little value	11	15%
No opinion	7	11%
Reasonable condition with need in some areas for improvement	6	9%
Good condition with no need for improvement	0	0%
	70	100%

Question D

Which stormwater problems should the plan focus on?

Please rank each of the characteristics below out of 7, with 1 being very important and 7 being least important.

If you think a number of options are equally important please give them the same ranking.

		Rating							
	Mean Rating	0	1	2	3	4	5	6	7
Stormwater runoff from residential areas	3.6	3%	34%	8%	2%	16%	2%	13%	23%
Stormwater runoff and sediment from construction activities	3.1	11%	32%	6%	8%	3%	15%	16%	8%
Stormwater runoff from roads, railways and airport activities	2.9	3%	32%	21%	8%	6%	16%	6%	6%
Runoff and contamination from commercial and industrial areas	2.3	3%	48%	10%	15%	11%	6%	5%	2%
Litter entering the stormwater system and dumping of rubbish in watercourses	2.5	5%	39%	13%	18%	5%	13%	3%	5%
Sewer overflows, illegal connections and leaks from the sewerage system	2.2	3%	44%	23%	8%	11%	5%	5%	2%
Chemicals from old waste landfills and contaminated sites leaking into the waterways	2.6	3%	40%	19%	10%	11%	3%	3%	10%

Interest		
Resident	13	19%
Business	7	10%
Developer	15	21%
Community Interest	21	30%
Environment	10	16%
Other	3	4%
TOTAL	70	100%

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Appendix B

Community Comments

Community Comments received in response to the Questionnaire

Comments regarding the use of the waterways.

- Sections of the river could be lined and (partially) covered as a pedestrian walkway.
- Attempts have been made since 1929 to clean up the Cooks River. Nothing has succeeded yet. It is long overdue for urgent attention now.
- The Cooks River looks like a drain, even if the water quality is improved to allow safe swimming, fishing etc, it is not a 'river' due to the lack of natural features. Stormwater management and river naturalisation needed to change the image of the river.
- Cooks River is very dangerous. The public is warned not to swim in it nor eat the fish. Doesn't get worse than that.
- There must be stricter penalties and fines for culprit companies dumping illegal toxics into stormwater. Whether its throwing a chip packet on the ground or washing your car on the road. Every single aspect must be looked at carefully and policed.
- Clean up around the airport - rubbish.
- If the river is made safe for recreational usage, then the Cooks River will again become an asset and not a commercial sewer.
- Healthy societies need a good balance of work and recreation. Water related recreation areas offer the largest variety of activities that can be conducted simultaneously and to the widest range of areas.
- I doubt we could get oyster farming back, look at what happened in the Georges River. Besides the Cooks River is very small. From our point of view, the cycleway is very important.
- Restoration of functioning, terrestrial and aquatic ecosystems is a high priority.
- Commercial operations would only add to the pollution.
- Foreshore protection zones need to be retained ie. the les development along river shores.
- Anything commercial gives the impression of getting away with some pollution.
- Power boats (ski's) etc can contribute to erosion and disturb animals and habitat.
- The Cooks River bike and walking track is one of the prettiest and most popular paths in the district. It is crowded on weekends. Cleaning up the river might make it viable to have successful teahouses/restaurants as stopping places along the route.

Comments regarding the condition of the waterways.

- The residential and mixed industrial character of the catchment combined with pollution of the water and air could lead to health hazards.
- No. 1 couldn't be any further from the truth
- A special levy should be set up to fund this large project. Perhaps levy each house living in the catchment and double or triple levy to all factories discharging to the river.

- The river is treated like a drain but still retains natural wildlife and value. More concern and funding needed for its improvement.
- Having state the river is a drain, we (River Canoe Club), have noticed an improvement in water quality (at times) with more fish and shellfish (and birds) in the river, but there are still days of smelly (chemical like) water.
- One of Australia's most polluted estuaries.
- Failure of government to take action ie. toxic fish, sewage overflows etc. Governments don't want the community to know.
- I regularly walk along the river from Wardell Road through Tempe Station and sometimes through the airport. I think the walkways and plant and birdlife have improved considerably. But there is still a lot of rubbish- bottles, plastic ending up in the river.
- The Cooks River is also a dumping ground for many. I stress this point once more, more stringent penalties and inspectors (full time) monitoring water quality once a standard water quality has been achieved.
- Remediate some of the smaller tributaries using community groups (bushcare), urban streams movement. Information available from DLWC
- I would like to have been able to tick number 4, but with the rivers present condition and continued developments along its banks and in its catchment I'm afraid I can't honestly do so.
- Rather than an asset to Sydney, surely the River is a liability it is a degraded stormwater channel basically with no mangroves along its banks to provide filtration.
- Downside the river is lost, upside is we can rebuild the river. We would all like to enjoy the river in our lifetime and leave something for the next generation.
- Captain Cook referred to the Cooks River in his journal as a "fine and clean system" from which he took fresh water. A lot has changed.
- My view is while the environmental qualities of the river are seriously degraded, this is no reason to ignore the potential that exists for significantly improving the quality of the river.
- The re-establishment of mangroves is a sign of environmental fightback on the Cooks River as is the presence of saltmarsh plant species along some stretches eg. east of Illawarra Road, Marrickville. Wolli Creek still retains significant native vegetation along its length (from Bexley north eastwards), ditto Bardwell creek.
- I would have ticked no.2 however the river just needs some value adding by not being used as a no.1.
- Larger industries get away with spillage and no fines. We have to strike everyone who causes pollution to the waterways with very large fines and make it well known. The general public should also be fined for leaving the surrounding parks littered. No one organisation will implement guidelines / fines.
- The river is degraded but is still of high recreational value for walking and cycling beside etc.
- This is a subjective choice only. To make an informed comment flora and fauna data would need to be viewed.

- There should be punitive additional Council rates for owners/developers who build and pave over (more that) 50% of their land area. Overdevelopment and concreted yards cost the community dearly in terms of pollution and loss of amenity - those who cause the problem should pay to fix it.

Comments regarding which problems the plan should focus on.

- Pollution should be controlled at the source before discharged to the river.
- No mention was made of urban weeds, dumped in the bush and river. These add nutrients to the river directly or indirectly.
- Education of all residents in the catchment regarding minimising pollution from the home via printed material in all languages, and heavy fines imposed on all illegal connection of plumbing leading to pollution.
- A holistic approach improving all sources of pollution is needed.
- If all problems can be addressed at the same time and locals can see something happening on a large scale, they may feel their own efforts are worthwhile and support the river.
- All equally important, is the accumulation effect, combination of all and long term.
- Sydney Water would be the biggest water polluter followed by stormwater.
- I think that mesh fencing around certain areas would also greatly help preventing rubbish entering the system.
- Recently there has been contamination of Cox's Creek which resulted in the death of native fish living in this small comparatively clean tributary. Further up on what was railway land at Chullora massive land and track works are occurring.
- Strategy for improvement will vary depending on which part of the River you are dealing with
- Continued monitoring of trade waste should be a priority. There needs to be a reduction in trade waste targets so that when sewer overflows occur, trade waste does not flow into the river.
- More labels/diagrams painted on stormwater drains " Do not Pollute" " Protect the Environment". Stricter controls on sediment runoff from construction activities.
- Too many government agencies still "clean up" community messes by washing down instead of wet vacuuming cleanups or sweeping / shovelling up into containers. eg. motor vehicle accidents, broken car parts swept aside and left, oils hosed down drains and not into booms and sucked up.
- Dumped cars in Cooks Rover near the airport.
- All these activities create chemical contaminants. Data on the extent of each land use activity would need to be viewed to assess priorities.
- There needs to be a multi-lingual education campaign about individual responsibilities in improving the catchment areas. And it needs to be sustained. The Government needs to re-think its Urban Consolidation Policy. In looking after the health of the Hawkesbury it is ensuring the destruction of the rest of Sydney’s Rivers.

Comments Regarding any pollution problems or other general comments.

- I am the project engineer for the East Hills railway maintenance, and as such, it would prove beneficial for me to gain a greater understanding of the rail corridor impact on the Wolli Creek / Cooks River.
- Domestic and industrial pollution.
- I live in a developing residential areas at Menai. The major pollution problem is from construction activities.
- A significant length of riverbank is not generally on view to the public with the result that people do not have any/much knowledge of the problems (if Botany Bay looked like most of the river bank people would be irate) - perhaps encouraging better access would be in the rivers interest.
- Illegal rubbish dumping and contaminants seem to be the most frequent problem for waterway pollution in all ares in and around Sydney.
- There are sewage leaks in Girraween Park, especially after rainfall when manholes overflow.
- The residential dumping of oil, paint, household chemicals down the stormwater system and into the river must be stopped. A door knock campaign by all environmental groups throughout the urban catchment needs to be done to raise awareness.
- After rain the river is clogged with litter such as plastic bags and drink bottles, while mainly visual, this influences peoples perceptions of the river. While canoeing/training have been chemical smells and oily patches on the water around Tempe.
- We have a stormwater pipe running through our site (Australian golf club, Rosebury), which carries large volumes of rubbish etc, that desperately needs council attention.
- Canal grates are ineffective and rarely cleared. River bottom sludge is too thick killing aquatic vegetation and therefore no food chain.
- I live at Kurnell (previously in Kingsgrove) and whilst regularly walking along the beaches in Botany Bay I encountered piles of litter brought onto the beach. I can only conclude it is washing into the bay from the Georges and Cooks River Systems.
- We would expect environmental consultants to know the issues and inform the community. Sydney Water, Fisheries and EPA should be able to deliver the answers.
- The water entering Strathfield Golf Club from the west is fairly regularly contaminated with a very foaming solution. A new and large drain is being built in concrete from near the cemetery entrance to the river.
- I used to work in the excavation industry and nearly every time dewatering was required, water would be pumped directly into drains using no filtration or hay bails. This also occurs within the Burwood Municipal Area.
- Dog droppings are a big problem.
- A group of people who visited out reserve via the drain system which the creek enters wrote on the notice board that " the creek stinks and is full of sewer runoff". This is no always so , but has been particularly so since it has started raining heavily.
- Most significant problems in the upper catchment seem to be litter and weed infestation (councils and local residents could manage these). In lower catchment these problems are

even more significant and substantial development and industry place additional stress such as sediment, leachate from old landfills sites etc.

- Near Mackay Park Tempe (Unwins Bridge) the levels of sludge are very bad, especially if you upset them ie step in them. The surprising thing is that there are some nice dandy sections in the river near the airport. How magnificent would the river be if the sludge was removed and the sand returned?
- Noise pollution in Surrey Hills areas and litter in the streets.
- Stop it getting in then clean it out.
- The end of pipe with engineer solution - man made wetlands, traps and sediment pits. Allow the public to treat stormwater runoff within their own property - rubble drains, sediment pits, storage tanks. Once sediment and contaminants have stopped entering the river remove or cap existing sediment beds and stabilise banks with random sized rock water courses and selective plant stabilisation. Create ongoing program to remove sediment from man made wetlands.
- Litter, sediment from building sites, industry from premises located on the canal discharging illegally and polluting the river.
- I can't know which is are the most damaging. You should conduct experiments and design a plan to meet the goals of question B. Without having tested the things above, how can I know which are the worst?
- People wash their cars and trucks on the road, therefore more ads needed in local papers tells/shows dirt/suds/oil etc entering stormwater system. Provide incentives such as coupons for people to wash their vehicles at wash stations. Current commercial excellent showing the drain is just for rain, we need more ads like this.
- Stormwater runoff and siltation.
- Building reconstruction sites including smaller works by owner/occupiers. Carwashing on the street or driveways. Too many trades-people still think its OK to make a mess (concreters and plumbers) and clean-up afterwards by washing matter down the drain.
- Litter/rubbish pollution is the most visible problem, however stormwater volumes and associated water quality are more worrying although less obvious to the "everyday eye". Increase nutrients are also supporting aquatic weed infestations eg. water hyacnth and bankside weeds.
- Can't understand why we don't have tertiary treatment of everything.
- Report was made to Strathfield Council Monday 5/10/98. Mr Sam Coppelli who said he would report back to me, 29/10 no response. Soapy water coming from Cox's Creek seen Saturday 3/10/98 - sited just west of Water St Belfield Bridge.
- Contamination of underground water. Southlands and other areas of Orica Chemical Company run off into Botany Bay.
- Litter from picnic areas. Dumping of cans and rubbish.
- Parramatta, Pacific Hwy and Princess Hwy need to be rethought on how to take the environmental damage aspect into consideration. Backyard and community/council need to work together to make a change. I think if waste management was well established the problem would halve.

- These comments are purely subjective and come from the point of view of a neighbouring council outside the catchment. Biodiversity is seen by the Bushland Co-ordination of Randwick City Council to be of utmost importance. All the questions mentioned above affect biodiversity.
- Keep community involved as much as possible through information programs in local press, including ethnic and other languages.
- Improved street cleaning services and catchment facilities needed. Ban junk mail which ends up in the gutter. Incentive schemes for residents to keep drains rubble free. Better public and community education.
- You should be allowed to have a rainwater tank. Loss of environmental flow, retention basins, gully traps.
- The river has traps and nets which are apparently not regularly cleaned out. What is the purpose of collecting rubbish, if it is only to stay in or beside the river? These need to be cleaned out at every turn of the tide.
- Litter from picnic areas. Dumping of cars and rubbish.

Appendix C

Community Stakeholders

COOKS RIVER CATCHMENT COMMUNITY CONTACT LIST

Name	Job Title	Company	City	Postcode
	The General Manager	A & F Tonna Motor Repairs	BEACONSFIELD	2015
	The General Manager	AA Custom Spray Panel Beaters	ST PETERS	2044
	The General Manager	AAA Power Parts	ST PETERS	2044
	The General Manager	Active Air Conditioning	MASCOT	2020
	The General Manager	Aircraft Laundry	ST PETERS	2044
	The General Manager	Allkool Equipment	ST PETERS	2044
	The General Manager	Alsco Linen Services	BEACONSFIELD	2015
	The General Manager	Ansett Air Freight	BEACONSFIELD	2015
Mr Peter Sindrey		Ansett Australia	MASCOT	2020
	The General Manager	ANU Container Services	ST PETERS	2044
Mr R West		Arncliffe Progress Association	ARNCLIFFE	2205
	The General Manager	Associated Plastics Pty Ltd	ST PETERS	2044
Mr Roger C Morris	Secretary Manager	Australian Golf Club	ROSEBERY	2018
	The General Manager	Australian Lebanese Christian Foundation	PUNCHBOWL	2196
	The General Manager	Australian Technical Supplies	ST PETERS	2044
	The General Manager	B & M Foods Pty Ltd	BEACONSFIELD	2015
Maria Ledson		Bankstown Bushland Society	GREENACRE	2190
Mr Robert Balzola		Bankstown Bushland Society	PANANIA	2213
Mrs E Daly		Bardwell Creek Progress Association	BEXLEY NORTH	2207
Mr Perce Short		Bass Sydney Fishing Club	PARRAMATTA	2126
	The Principal	Belmore Boys High School	BELMORE	2192
	The Principal	Bethany College	HURSTVILLE	2220
	The General Manager	Bev Martin Textiles Pty Ltd	ST PETERS	2044
Mr George Alidenes	President	Beverly Hills Chamber of Commerce	BEVERLY HILLS	2209
	The Principal	Beverly Hills Girls High School	BEVERLY HILLS	2209
Grahame Peak		Beverly Hills Progress Association	BEVERLY HILLS	2209
	The General Manager	Boral Site	ST PETERS	2044
Mr Bernie Clark		Botany Bay Planning and Protection	OYSTER BAY	2225
Mrs L Wolfram		Botany Eastern Region EPA	MASCOT	2020
Mr Aub Eardley		Botany Enterprise Centre	EAST BOTANY	2019
Karyn Green	Secretary	Botany Historical Trust	MAROUBRA	2035
Ms N Hillier		Botany/Botany Bay Environment Watch	BOTANY	2019
	The General Manager	Braemac Pty Ltd	ST PETERS	2044
	The General Manager	Burlington Air Express	BEACONSFIELD	2015
C/-Tina Digby		Bushcare Group, Randwick Community Nursery	KINGSFORD	2032
	The Principal	Canterbury Boys High School	CANTERBURY	2193
Cr John Hazistergos		Canterbury City Council	CAMPSIE	2194
Amelia Newman		Canterbury District Resident & Ratepayers Ass	BELMORE	2192
	The Principal	Canterbury Girls High School	CANTERBURY	2193
Lesly Muir* and Brian Madden*		Canterbury Historical Society	KINGSGROVE	
	The Principal	Casimir College	MARRICKVILLE	2204
Steven Lee*		CDM Intl(s) Pty Ltd	ENFIELD	2136
Jenny Lee*		CDM Intl(s) Pty Ltd	ENFIELD	2136
	The General Manager	*Central Scrap and Recycling*	*ST PETERS*	*2044*
Ian Kiernan		Clean Up Australia Campaign	PYRMONT	2009
Kath King*		Clean Ups Cooks River	CAMPSIE	2194
Neil Worsley		Cleveland Street High School	ALEXANDRIA	2015
	The Principal	Commerce Our Lady of the Rosary School	KENSINGTON	2033
Mr Ron Farrell		Cooks River Annual Festival Team	EARLWOOD	2206
Mr David Beynon		Cooks River CMC Member	NEWTOWN	2042
Dr Craig Blundell		Cooks River CMC Member	ALEXANDRIA	2015
Mr Dominic WYKanak		Cooks River CMC Member	BEXLEY	2207
Mr Don Elvy		Cooks River CMC Member	STANMORE	2048
Mr Robert Fenton		Cooks River CMC Member	BEXLEY	2207
Mr Simon Mitrovic		Cooks River CMC Member	PUNCHBOWL	2196
Ms Janelle Reynolds		Cooks River CMC Member	KINGSGROVE	2208
Bryan Hall*		Cooks River CMC Member	KINGSGROVE	2208
Gary Blanschke*		Cooks River Coalition	BELMORE NORTH	2192
Terrill Nordstrom*		Cooks River Coalition	GREENACRE	2190

Name	Job Title	Company	City	Postcode
Norma Dawson		Cooks River Motor Boat Club	TEMPE	2044
Mrs L Rose		Cooks River Valley Association	CAMPSIE	2194
Mr Ron Farrell*		Cooks River Valley Association	UNDERCLIFFE	
Chris Belle*		Cooks River Valley Association	EARLWOOD	
Phil Herring*		Cooks River Valley Association	MARRICKVILLE	
	The General Manager	Corporate Apparel Group	BEACONSFIELD	2015
		Council Eastern Suburbs	OYSTER BAY	2225
	The General Manager	Crown St Public School	ST PETERS	2044
	The Principal	Danebank Girls	HURSTVILLE	2220
Mr Colin Gale		Darug Link Inc.	BLACKTOWN	2148
Clr F Dominelli		Dominelli Ford	HURSTVILLE	2220
	The General Manager	Double Swan Pty Ltd	BEACONSFIELD	2015
		Earlwood Caring Community Centre	EARLWOOD	2206
		Eastern Region Environmental Watch	MATRAVILLE	2036
Jeff Ash		Eastern Suburbs Green	DOUBLE BAY	2025
	The General Manager	Eastern Suburbs Newspapers	BEACONSFIELD	2015
	The General Manager	Erskinville Public School	ERSKINVILLE	2015
	The General Manager	Factory Export	ST PETERS	2044
	The General Manager	FDC Building Services	BEACONSFIELD	2015
Jean Brian*		Friends of Cox's Creek	YAGOONA	
Maree Ledson*		Friends of Cox's Creek	GREENACRE	
Ted Floyd		Friends of the Earth	SYDNEY SOUTH	1235
Mr Stuart White		Friends of the Earth	SYDNEY SOUTH	1235
Owen Wholohan		Friends of Wolli Creek	BEVERLY HILLS	2209
Cliff Williams*		Friends of Wolli Creek	BARDWELL PARK	
Chris Terkins*		Friends of Wolli Creek	MONTEREY	
	The General Manager	Fujitsu	BEACONSFIELD	2015
	The General Manager	Gidd Precision Engineers	ST PETERS	2044
	The General Manager	Greek Orthodox Community of NSW	LAKEMBA	2195
Mr Paul Cruickshank		Greening Australia (NSW) Inc.	SYDNEY	2001
		Greenpeace	BALMAIN	2041
	The General Manager	Heritage Stone Masonry Public	ST PETERS	2044
		Hurstville Boys High School	HURSTVILLE	2220
Mr Sam Nasser	President	Hurstville Chamber of Commerce	HURSTVILLE	2220
Cr John Griffin		Hurstville City Council	HURSTVILLE	2220
		Hurstville Public School	HURSTVILLE	2220
Brian Shaw		Hurstville Residents Association	OATLEY	2230
Mr Greg Briscoe	Secretary	Hurstville Residents Association	OATLEY	2223
Merrick Plater		Hurtsville BHS Stream Watch	EARLWOOD	
Chris Little*		Hurtsville City Council	HURTSVILLE	2220
Merv Lynch*		Hurtsville City Council	PENTHURST	2222
	The General Manager	Imperial Hire Cars	ROSEBERRY	2018
	The General Manager	Ingram Automotive Parts	ST PETERS	2044
	The General Manager	International Freight Service	BEACONSFIELD	2015
Lee Squires		Joint Committees Necropolis Trust		
Michelle Gapes		Keep Australia Beautiful Council	SYDNEY	2000
	The General Manager	Kennards Hire	ROSEBERRY	2018
Mr Andrew Zelnik	Secretary	Kensington Precinct Committee	KINGSFORD	2032
	The General Manager	Kettle Chips	ST PETERS	2044
	The Principal	Kingsgrove High School	KINGSGROVE	2208
	The Principal	Kingsgrove North High School	KINGSGROVE	2208
	The Principal	Kogarah High School	KOGARAH	2217
	The General Manager	Kwik Lok Australia	ST PETERS	2044
Nasser Roumier		Lebanese Moslems Association	LAKEMBA	2195
	The General Manager	M & D	ST PETERS	2044
Mr Chris McGuigan		Marrickville Community Training Centre Inc.	MARRICKVILLE	2204
Cr Phil Morgans		Marrickville Council	PETERSHAM	2049
	The General Manager	Marrickville Heritage Society	MARRICKVILLE	2204
	The Principal	Marrickville High School	MARRICKVILLE	2204
Phillip Fheard		Marrickville/South Sydney Bicycle Group	MARRICKVILLE	
Mr Geoffrey Phipps		Marrickville/South Sydney Bicycle Group	ALEXANDRIA	2015
Mr Malcolm Pettinger		Masters Plumbers Association	HABERFIELD	2045
	The General Manager	Mayfair International	ST PETERS	2044
Leo McLeay		Member of Parliament (Federal) Watson	REVESBY	2212
Morris Iemma		Member of Parliament (State) Hurstville	RIVERWOOD	2210
Phillip Martin		Meriton Apartments	SYDNEY	2000

Name	Job Title	Company	City	Postcode
	The General Manager	Monmessi Motor Repairs & Smash Repairs Pty	ST PETERS	2044
	The General Manager	Morganite Insulating Products	BEACONSFIELD	2015
	The General Manager	MSAS Freight Transport	BEACONSFIELD	2015
		Narwee-Roselands Residents Association	NARWEE	2209
Mr Graham Quint		National Trust NSW	SYDNEY	2000
Jon Phillips		Newtown Neighbourhood Centre, Addison Rd C	SYDNEY	2000
	The General Manager	Nextex Australia	ST PETERS	2044
	The General Manager	NTT Office & Computers	BEACONSFIELD	2015
Ms Winters		Oatley Flora and Fauna Conservation Society	MORTDALE	2223
	The General Manager	Owens Transport	ST PETERS	2044
Debbie Arnold	The General Manager	P & O Food Catering	MASCOT	2020
	The General Manager	PDE International	ST PETERS	2044
Mr George Alidenes	President	Penshurst Chamber of Commerce	PENSHURST	2222
	The General Manager	Pioneer Road Services	ST PETERS	2044
Mr Hugh Livingstone		Q Stores	ALEXANDRIA	2015
Bruce Saunders		Qantas Safety and Environment Department	MASCOT	2020
	The General Manager	Quadric Interiors NSW	BEACONSFIELD	2015
David Gathercole		Randwick Earth Works Group	RANDWICK	2031
		Randwick Residents Action Group	COOGEE	2034
	The General Manager	Rapid Roller Pty Ltd	ST PETERS	2044
Mr John Holloway		Real Estate Institute	SYDNEY SOUTH	2000
	The General Manager	Redfern External Studies	PETERSHAM	2049
	The General Manager	Riley Albion NSW Pty Ltd	BEACONSFIELD	2015
	The General Manager	Riley St Public School	SURRY HILLS	2010
Ross Winters	The President	River Canoe Club of NSW	LAGANO	2210
Nola Taylor		Rockdale & District Landscape & Heritage Soci	BEXLEY	2207
Cr Ray Oxford		Rockdale City Council	ROCKDALE	2216
Mr Ron Rainer*		Rockdale Wetlands Preservation Society	ROCKDALE	2216
	The General Manager	Safes New & Used	MASCOT	2020
	The General Manager	Salmat	MASCOT	2020
	The General Manager	Sandblasting & Metalising Service	ST PETERS	2044
	The General Manager	Scaffolding & Heritage Roof	ST PETERS	2044
	The General Manager	Schenker International Freight Transport	BEACONSFIELD	2015
Mr John McMichin		Scouting Association of Australia St George Br	HURSTVILLE	2220
	The General Manager	Sims Metals	MASCOT	2020
	The General Manager	SOS Printing	ST PETERS	2044
	The Principal	South Sydney High School	MAROUBRA	2035
		South Sydney Hospital	ZETLAND	2017
Mr Frank Sartor		South Sydney Resident Action Group	NEWTOWN	2042
	The Principal	St Annes Catholic School	STRATHFIELD SO	2136
	The Principal	St Brigids	MARRICKVILLE	2204
	The Principal	St Dominic Savio	ROCKDALE	2216
	The Principal	St Gabriels	BEXLEY	2207
	The General Manager	St Maron's	SURRY HILLS	2010
	The General Manager	St Mary's	ERSKINVILLE	2015
	The General Manager	St Peter's	SURRY HILLS	2010
	The General Manager	St Peter's Public School	ST PETERS	2044
		St Peters, Sydenham, Tempe Community Asso	SYDENHAM	2044
	The General Manager	Strang Container	MASCOT	2020
Virginia Tudge*		Strathfield Council	STRATHFIELD	
	The Principal	Strathfield Girls High School	STRATHFIELD	2135
	The Principal	Strathfield South High School	STRATHFIELD	2135
Malcolm Knowles	The General Manager	Sydney Recycling Centre	ALEXANDRIA	2044
	The Principal	Sydney Technical High School	BEXLEY	2207
Mr Craig Crawley		Sydney Water, Central Region	ROCKDALE	2216
	The General Manager	Taji Book Sellers	BEACONSFIELD	2015
	The General Manager	Tasman Suppliers	ALEXANDRIA	2015
	The General Manager	TC's Smash Repairs	BEACONSFIELD	2015
Jeff Angel		Total Environment Centre	SYDNEY	2000
Nola Taylor		Transport Action Group Against Motorways	BEXLEY	2207
	The General Manager	Ultra Safe Australia Pty Ltd	ST PETERS	2044
Mr Garry West		Unifoods	EPPING	2121
Mr Angelo Bavaro		University of New South Wales	OATLEY	2223
	The General Manager	Vienna Patisserie	BEACONSFIELD	2015
Lee Hoffman		Wolli Creek Preservation Society	EARLWOOD	2206
Ms Judy Finlayson		Wolli Creek Protection Society - Canterbury		

Name	Job Title	Company	City	Postcode
Alan Leishma*			ST PETERS	
Andrew Adams*			DULWICH HILL	
Audrey Henchman*			CAMPSIE	2194
Brenda Llewelyn*			MARRICKVILLE	2204
Clr B. Giegerl J.P			MARRICKVILLE	2204
Clr B. McDonald J.P			PEAKHURST	2210
Clr C.G. Neil			CRONULLA	2230
Clr J Griffin			HURSTVILLE	2220
Clr M.M Smith			PEAKHURST HEIGHTS	2210
Clr M.O. Frawley			PENSHURST	2222
Clr M.V. Lynch J.P			LUGARNO	2210
Clr P Olah			LUGARNO	2210
Clr P.R. Sansom			LUGARNO	2210
Clr R.A.A Stewart			LUGARNO	2210
Clr W.F. Pickering J.P			LUGARNO	2210
D. Nelson* and G.Nichols*			HURTSVILLE	2220
Dr Malcolm Buck			STRATHFIELD	2135
G. Russell*			SOUTH STRATHFI	2136
Geoff Warde*			STRATHFIELD	2135
Helen Jones			ST PETERS	2044
Ian Phillips*			ASHBURY	2193
Laurence Atkin ^			BELFIELD	2191
Leo Duffs*			LUGARNO	2210
Liz Maher*	Deputy Mayor		HURSTVILLE	2220
Melanie Pittard*			PENSHURST	2222
Noel and Dorothy Leaudals*	Mayor		PENSHURST	2222
Pat Giammarco			MORTDALE	2223
Patricia Parkinson			PEAKHURST	2210
Penny Hopkins*			CARINGBAH	2229
Richard Randall			LUGARNO	2210
Steve Corbett			LUGARNO	2210
Susan Hemsley*	Deputy Mayor		PEAKHURST HEIG	2210
Tracey Slater*			LUGARNO	2210

* Those who attended the community workshops.
^ Sent in letter expressing views

Appendix E

Native Vegetation Species List

Native Vegetation Species List for the Cooks River Valley

(Source: Cooks River Foreshores Strategic Plan, 1997)

Species name	Common name
Acacia binervia (syn. Acacia glaucescens)	Coast Myall
Acacia brownei	Prickly Moses
Acacia bynoeana	
Acacia decurrens	Sydney Green Wattle
Acacia falcata	Sickle Wattle
Acacia floribunda	Sally Wattle
Acacia genistifolia	Early Wattle
Acacia hispidula	
Acacia implexa	Hickory
Acacia linifolia	Flax-leafed Wattle
Acacia longifolia	Sydney Golden Wattle
Acacia longissima	
Acacia myrtifolia	Myrtle Wattle
Acacia obtusifolia	
Acacia parramattensis	Parramatta Green Wattle
Acacia pubescens	Downy Wattle
Acacia sophorae	Coast Wattle
Acacia stricta	Straight Wattle

Species name	Common name
Acacia suaveolens	Sweet-scented Wattle
Acacia terminalis	Sunshine Wattle
Acacia ulicifolia	Prickly Moses
Acaena novae-zelandiae	Bidgy-widgy
Acianthus exsertus	Gnat Orchid
Acmena smithii	Lillypilly
Actinotus helianthi	Flannel Flower
Actinotus minor	
Adiantum aethiopicum	Maidenhair Fern
Aegiceras corniculatum	River Mangrove
Agrostis aemula	Blown Grass
Agrostis avenacea	Blown Grass
Agrostis billardieri	Blown Grass
Allocasuarina littoralis	Black She-oak
Alphitonia excelsa	Red Ash
Alternanthera denticulata	Lesser Joyweed
Amperea xiphoclada	Broom Spurge
Amyema congener ssp. congener	Mistletoe
Amyema gaudichaudii	Paper-bark Mistletoe
Amyema pendulum	
Angophora bakeri	Narrow-leafed Apple

Species name	Common name
Angophora costata	Sydney Red Gum
Angophora floribunda	Rough-barked Apple
Angophora hispida	Dwarf Apple
Anisopogon avenaceus	Oat Speargrass
Aotus ericoides	
Aristida ramosa	Three-awn Speargrass
Aristida vagans	Three-awn Speargrass
Aristida warburgii	
Arthropodium milleflorum	Vanilla Lily
Asplenium australasicum	Bird's Nest Fern
Asplenium flabellifolium	Necklace Fern
Astroloma humifusum	Native Cranberry
Astroloma pinifolium	
Atriplex australasica	Saltbush
Atriplex semibaccata	Berry Saltbush
Avicennia marina var. australasica	Grey Mangrove
Azolla filiculoides var. rubra	Azolla

Species name	Common name
Backhousia myrtifolia	Grey Myrtle
Baeckea linifolia	Heath-myrtle
Banksia aemula	Wallum Banksia
Banksia integrifolia	Coastal Banksia
Banksia oblongifolia	
Banksia serrata	Old Man Banksia
Banksia spinulosa	Hair-pin Banksia
Bauera rubioides	River Rose
Baumea articulata	Twig-rush
Baumea juncea	
Billardiera scandens	Apple Berry
Blandfordia nobilis	Christmas Bells
Blechnum cartilagineum	Gristle Fern
Blechnum indicum	Bungwall Fern
Bolboschoenus caldwellii	Rush
Bolboschoenus fluviatilis (syn. Scirpus fluviatilis)	Club-rush
Boronia polygalifolia	Milkwort Boronia
Bossiaea heterophylla	
Bossiaea prostrata	
Bothriochloa decipiens	
Bothriochloa macra	

Native Vegetation Species List for the Cooks River Valley

(Source: Cooks River Foreshores Strategic Plan, 1997)

Species name	Common name
Brachyloma daphnoides	Daphne Heath
Breynia oblongifolia	Breynia
Burchardia umbellata	Milkmaids
Bursaria spinosa	Blackthorn
Caesia parviflora	Grass-lily
Caesia parviflora var.vittata (syn. Caesia vittata)	Grass-lily
Callicoma serratifolia	Black Wattle
Callistemon citrinus	Crimson Bottlebrush
Callistemon linearis	Narrow-leaved Bottlebrush
Callistemon pinifolius	
Callistemon rigidus	Stiff Bottlebrush
Callitriche stagnalis	
Calochilus campestris	Copper Beard Orchid
Calochlaena dubia (syn Culcita dubia)	False Bracken Fern
Calotis cuneifolia	Blue Burr-daisy
Calotis lappulacea	Burr-daisy
Calystegia sepium	Bindweed
Capillipedium spicigerum	Scented Top
Carex appressa	
Carex fascicularis	Tassel Sedge

Species name	Common name
Carpobrotus glaucescens	Pig Face
Cassinia aculeata	
Cassinia arcuata	
Cassinia aureonitens	
Cassinia longifolia	
Cassinia quinquefaria	
Cassinia trinerva	
Cassinia uncata	
Cassytha glabella	Devil's Twine
Cassytha pubescens (syn. Cassytha paniculata)	Devil's Twine
Casuarina glauca	Swamp She-oak
Cayratia clematidea	
Centaurium spicatum	
Centella asiatica	
Centipida minima	
Centrolepis fascicularis	
Centrolepis strigosa	
Ceratopetalum apetalum	Coachwood
Ceratopetalum gummiferum	Christmas Bush

Species name	Common name
Chellanthes sieberi	Mulga Fern
Chiloglottis reflexa	Ant Orchid
Chionochloa pallida (syn. Danthonia pallida)	Silvertop Wallaby Grass
Chloanthes stoechadis	
Chloris truncata	Windmill Grass
Christella dentata	
Chrysocephalum apiculatum (syn. Helichrysum apiculatum)	Yellow Buttons
Chrysocephalum semipapposum	Yellow Buttons
Cissus hypoglauca	Native Grape
Cladium procerum	Tall Twig Rush
Clematis aristata	Old Man's Beard
Clematis glycinoides	Old Man's Beard
Clerodendrum tomentosum	
Commelina cyanea	
Conospermum longifolium	Cone-seed
Convolvulus erubescens	Bindweed
Correa reflexa	
Corybas aconitiflorus	Cradle Orchid
Corymbia gummifera (syn. Eucalyptus gummifera)	Red Bloodwood

Species name	Common name
Cotula australis	
Cotula coronopifolia	Water Buttons
Crassula helmsii	
Crassula sieberana	
Cyathea australis	Rough Treefern
Cyathochaeta diandra	
Cyclorus interruptus (syn. Cyclosurus gongylodes)	Shield Fern
Cymbopogon refractus	Barbed-wire Grass
Cynodon dactylon	Common Couch
Cyperus brevifolius	Mullumbimby Couch
Cyperus difformis	
Cyperus enervis	
Cyperus gracilis	
Cyperus imbecillis	
Cyperus laevigatus	
Cyperus mirus	
Cyperus polystachyos	
Cyperus sanguinolentus	
Cyperus sphaeroideus	
Damplera stricta	
Danthonia linkii var. linkii	Wallaby Grass
Danthonia setacea	Wallaby Grass

Native Vegetation Species List for the Cooks River Valley

(Source: Cooks River Foreshores Strategic Plan, 1997)

Species name	Common name
Danthonia tenuior	Wallaby Grass
Daviesia ulicifolia	
Dendrobium teretifolium	Pencil Orchid
Dendrophthoe vitellina	Mistletoe
Desmodium rhytidophyllum	
Deyeuxia quadriseta	Bent grass
Dianella caerulea	Flax Lily
Dianella caerulea var. producta	Flax Lily
Dianella longifolia var. longifolia (syn. Dianella laevis)	Flax Lily
Dianella revoluta	Flax Lily
Dichelachne crinita	Plume Grass
Dichelachne inaequiglumis	Plume Grass
Dichelachne micrantha	Plume Grass
Dichelachne parva	Plume Grass
Dichelachne rara	Plume Grass
Dichondra repens	Kidney Weed

Species name	Common name
Dichondra sp A.	
Digitaria diffusa	Fingergrass
Digitaria parviflora	Fingergrass
Dillwynia sieberi (previously included in Dillwynia juniperina)	
Dillwynia parviflora	
Dillwynia retorta (includes ssp. A)	Parrot Pea
Dodonaea triquetra	Hop Bush
Dodonaea viscosa	
Drosera auriculata	Sundew
Drosera peltata	Sundew
Drosera spathulata	Sundew
Echinopogon caespitosus var. caespitosus	Hedgehog Grass
Echinopogon ovatus	Hedgehog Grass
Einadia hastata (syn. Rhagodia hastata)	Berry Saltbush
Einada nutans (including ssp. linifolia)	Climbing Saltbush
Einada polygonoides	
Einada trigonos ssp. trigonos	Fishweed
Elaeocarpus reticulatus	Blueberry Ash
Elatine gratioloides	Waterwort
Eleocharis acuta	Spike-rush

Species name	Common name
Eleocharis cylindrostachys	Spike-rush
Elymus scaber	Wheatgrass
Entolasia marginata	Bordered Panic
Entolasia stricta	Wiry Panic
Epacris longiflora	Native Fuchsia
Epacris microphylla	Coral Heath
Epachris pulchella	Coral Heath
Epachris purpurascens var. purpurascens	
Epaltes australis	
Epilobium billardieranum (including ssp. cinereum and ssp. hydrophilum)	
Epilobium hirtigerum	
Eragrostis benthamii	Love Grass
Eragrostis brownii	Brown's Love Grass
Eragrostis elongata	Love Grass
Eragrostis leptostachya	Love Grass
Eragrostis parviflora	
Eriochloa pseudoacrotricha	Early Spring Grass
Eriostemon australasius	Pink Wax Flower
Eriostemon scaber ssp. scaber	Wax Flower

Species name	Common name
Eucalyptus botryoides	Bangalay
Eucalyptus capitellata	Brown Stringbark
Eucalyptus crebra	Narrow-leaved Ironbark
Eucalyptus eugenioides	Thin-leaved Stringybark
Eucalyptus fibrosa ssp. fibrosa	Broad-leaved Ironbark
Eucalyptus globoidea	White Stringybark
Eucalyptus gummifera (see Corymbia gummifera)	Red Bloodwood
Eucalyptus haemastoma	Scribbly Gum
Eucalyptus longifolia	Woollybutt
Eucalyptus moluccana	Grey Box
Eucalyptus paniculata	Grey Ironbark
Eucalyptus pilularis	Blackbutt
Eucalyptus piperita	Sydney Peppermint
Eucalyptus punctata	Grey Gum
Eucalyptus resinifera	Red Mahogany
Eucalyptus robusta	Swamp Mahogany

Native Vegetation Species List for the Cooks River Valley

(Source: Cooks River Foreshores Strategic Plan, 1997)

Species name	Common name
Eucalyptus saligna	Sydney Blue Gum
Eucalyptus tereticornis	Forest Red Gum
Eustrephus latifolius	Wombat Berry
Exocarpos cupressiformis	Native Cherry
Ficus rubiginosa	Port Jackson Fig
Fimbristylis dichotoma	
Gahnia clarkei	Sword Grass
Gahnia erythrocarpa	Sword Grass
Geranium homeanum	Northern Cranesbill
Gleichenia dicarpa	Coral Fern
Gleichenia microphylla	Coral Fern
Glochidion ferdinandi	Cheese Tree
Glycine clandestina	Love Creeper
Glycine microphylla	Love Creeper
Glycine tabacina	Love Creeper
Gnaphalium involucratum	
Gnaphalium sphaericum	

Species name	Common name
Gompholobium inconspicuum	
Gompholobium minus	
Gonocarpus micranthus	
Gonocarpus salsoloides	
Gonocarpus tetragynus	Raspwort
Gonocarpus teucrioides	Raspwort
Goodenia bellidifolia	
Goodenia hederacea	
Goodenia ovata	
Goodenia paniculata	
Goodenia stelligera	
Grevillea buxifolia	Grey Spider flower
Grevillea mucronulata	Green Spider Flower
Grevillea sericea	Pink Spider Flower
Grevillea sphacelata	Small Grey Spider Flower
Hakea dactyloides	Broad-leaved Hakea
Hakea sericea	Bushy Needlebush

Species name	Common name
Hardenbergia violacea	
Helichrysum scorpioides	Everlasting
Hemarthria uncinata	
Hibbertia aspera	Guinea Flower
Hibbertia bracteata	Guinea Flower
Hibbertia dentata	Guinea Flower
Hibbertia diffusa	Guinea Flower
Hibbertia empetrifolia	Guinea Flower
Hibbertia pedunculata	Guinea Flower
Hibbertia scandens	Guinea Flower
Hibbertia serpyllifolia	Guinea Flower
Histiopteris incisa	Batswing Fern
Hovea linearis	
Hybanthus monopetalus	
Hydrocotyle peduncularis	Pennywort
Hypericum gramineum	
Hypolaena fastigiata	Tassel Rope-rush
Hypolepis muelleri	Harsh Ground Fern

Species name	Common name
Imperata cylindrica var. major	Blady Grass
Indigofera australis	Native Indigo
Isachne globosa	Swamp Millet
Isolepis inundata	Club-rush
Isolepis nodosa	Club-rush
Isopogon anemonifolius	Drumsticks
Jacksonia scoparia	
Juncus continuus	Rush
Juncus flavidus	Rush
Juncus homalocaulis	Rush
Juncus kraussii	Rush
Juncus pallidus	Rush
Juncus planifolius	Rush
Juncus procerus	Rush
Juncus remotiflorus	Rush
Juncus subsecundus	Rush
Juncus usitatus	Rush
Kennedia rubicunda	Dusky Coral Pea
Kunzea ambigua	Tick Bush
Kunzea capitata	
Lagenifera stipitata	

Native Vegetation Species List for the Cooks River Valley

(Source: Cooks River Foreshores Strategic Plan, 1997)

Species name	Common name
Lambertia formosa	Mountain Devil
Lasiopetalum ferrugineum var. ferrugineum	Rusty Petals
Lasiopetalum parviflorum	
Laxmannia gracilis	Slender Wire-lily
Lepidosperma gunnii (syn. Lepidosperma lineare)	Sword-sedge
Lepidosperma laterale	Sword-sedge
Leptomeria acida	Native Currant
Leptospermum arachnoides	Spidery Tea-tree
Leptospermum continentale	
Leptospermum laevigatum	Coastal Tea-tree
Leptospermum polygalifolium (syn. Leptospermum flavescens)	Lemon-scented Tea-tree
Leptospermum trinervium (syn. Leptospermum attenuatum)	Paperbark Tea-tree
Lepyrodia scariosa	
Leucopogon amplexicaulis	
Leucopogon ericoides	Beard-heath
Leucopogon juniperinus	Beard-heath
Leucopogon lanceolatus	Beard-heath
Leucopogon microphyllus	
Lindsaea linearis	Screw Fern
Lindsea microphylla	Lacy Wedge Fern
Linum marginale	Native Flax
Lissanthe strigosa	Native Cranberry
Livistonia australis	Cabbage-tree Palm
Lobelia alata	
Lobelia dentata	
Lobelia gracilis	
Logania albiflora	
Lomandra cylindrica	Mat-rush
Lomandra filiformis (includes ssp. coriacea and ssp. filiformis)	Mat-rush
Lomandra glauca	Mat-rush
Lomandra longifolia	Mat-rush
Lomandra multiflora (includes ssp. multiflora)	Mat-rush
Lomandra obliqua	Mat-rush
Lomatia silaifolia	Crinkle Bush
Lythrum hyssopifolia	
Macrozamia communis	Burrawang
Macrozamia spiralis	
Marsdenia suaveolens	
Maundia triglochinoides	
Maytenus silvestrus	Orangebark
Melaleuca deanei	
Melaleuca decora	
Melaleuca ericifolia	Swamp Paperbark
Melaleuca erubescens	Swamp Paperbark
Melaleuca linariifolia	Snow-in-summer
Melaleuca nodosa	
Melaleuca quinquenervia	Broad-leaved Paperbark
Melaleuca styphelioides	Prickly-leaved Paperbark
Melaleuca thymifolia	
Micrantheum ericoides	
Microlaena stipoides	Weeping Meadow Grass
Microtis parviflora	Slender Onion Orchid
Microtis unifolia	Common Onion Orchid
Mimulus repens	Creeping Monkey-flower
Mirbelia rubifolia	
Monotoca elliptica	Tree Broom-Heath
Monotoca scoparia	
Muellerina celastroides	Coast Mistletoe
Muellerina eucalyptoides	Creeping Mistletoe
Notelaea longifolia	Mock Olive
Notelaea ovata	Mock Olive
Olax stricta	
Olearia microphylla	Bridal Daisy Bush
Olearia viscidula	
Omalanthus nutans (syn. Omalanthus populifolius)	Bleeding Heart
Omphacomeria acerba	Leafless Sourbush
Opercularia aspera	Stink Weed
Opercularia diphylla	Stinkweed
Opercularia varia	

Native Vegetation Species List for the Cooks River Valley

(Source: Cooks River Foreshores Strategic Plan, 1997)

Species name	Common name
Oplismenus aemulus	Basket Grass
Oplismenus imbecillis	Basket Grass
Orthoceras strictum	Horned Orchid
Oxalis exilis	
Oxalis perennans	
Oxylobium ilicifolium (see Podolobium ilicifolium)	
Ozothamnus diosmifolius (syn. Helichysum diosmifolium)	Everlasting
Pandorea pandorana	Wonga Wonga Vine
Panicum obseptum	Panic
Panicum simile	Panic
Paspalidium distans	
Paspalum distichum (syn. Paspalum paspalodes)	Water Couch
Patersonia fragilis	Purple Flag
Patersonia glabrata	Purple Flag
Patersonia longifolia	Purple Flag
Pelargonium inodorum	
Pellaea falcata var. falcata	Sickle Fern
Persicaria decipiens	Knotweed

Species name	Common name
Persicaria hydropiper	Knotweed
Persicaria lapathifolia	Knotweed
Persicaria orientalis (syn. Polygonum orientale)	Knotweed
Persicaria strigosa (syn. Polygonum strigosum)	Knotweed
Persoonia lanceolata	Geebung
Persoonia laurina	Geebung
Persoonia levis	Geebung
Persoonia linearis	Geebung
Petrophile pulchella	Cone-sticks
Philotheca salsolifolia	
Phlydrum lanuginosum	Woolly Frogmouth
Phragmites australis	Common Reed
Phyllanthus gasstroemii	Blunt Spurge
Phyllanthus hirtellus (syn. Phyllanthus thymoides)	
Pimelea linifolia	Rice Flower
Pittosporum revolutum	
Pittosporum undulatum	Sweet Pittosporum

Species name	Common name
Platylobium formosum	Flat-Pea
Platysace lanceolata	Native Parsnip
Platysace linearifolia	Carrot Tops
Platysace stephensonii	
Poa affinis	Tussock Grass
Poa sieberiana	
Podocarpus spinulosus	Plum Pine
Podolobium ilicifolium (syn. Oxylobium ilicifolium)	Native Holly
Polymeria calycina	Swamp Bindweed
Polyscias sambucifolia	Elderberry Panax
Pomaderris discolor	Pomaderris
Pomaderris elliptica	Pomaderris
Pomaderris ferruginea	Pomaderris
Pomaderris intermedia (syn. Pomaderris sieberana)	Pomaderris
Pomaderris lanigera	Pomaderris
Pomaderris ligustrina	Pomaderris
Pomax umbellata	
Poranthera corymbosa	

Species name	Common name
Poranthera microphylla	
Potamogeton ochreatus	
Potamogeton pectinatus	
Potamogeton tricarinatus (including Potamogeton australiensis)	
Pratia purpurascens	
Pseuderanthemum variabile	
Pseudonaphalium luteo-album (syn. Gnaphalium luteo-album)	
Psilotum nudum	Skeleton Fork-fern
Pteridium esculentum	Bracken Fern
Pterostylis concinna	Greenhood Orchid
Pterostylis grandiflora	Greenhood Orchid
Pterostylis nutans	Greenhood Orchid
Ptilothrix deusta (syn. Ptilanthelium deustem)	
Pultenaea daphnoides	Bush Pea
Pultenaea linophylla	Bush Pea

Native Vegetation Species List for the Cooks River Valley

(Source: Cooks River Foreshores Strategic Plan, 1997)

Species name	Common name
Pultenaea paleacea	Bush Pea
Pultenaea retusa	Bush Pea
Pultenaea stipularis	Bush Pea
Pultenaea villosa	Bush Pea
Ranunculus inundatus	Buttercup
Ranunculus lappaceus	Buttercup
Rapanea variabilis	Mutton Wood
Restio tetraphyllus var. meiostachyus	Tassel-cord Rush
Rhytidosporum procumbens (syn. Billardiera procumbens)	Appleberry
Rorippa laciniata	Marsh-cress
Rubus parvifolius	Native Raspberry
Rulingia dasyphylla (syn. Rulingia pannosa)	Kerrawang
Rumex brownii	
Ruppia maritima	
Samolus repens	Creeping Brookweed
Sarcocornia quinqueflora	Samphire
Sarcopetalum harveyanum	Pearl Vine
Scaevola calendulacea	Fan Flower
Scaevola ramosissima	Fan Flower

Species name	Common name
Schoenoplectus litoralis (syn. Scirpus litoralis)	Club-rush
Schoenoplectus validus (syn. Scirpus validus)	Club-rush
Schoenus apogon	
Schoenus melanostachys	
Sclerolaena muricata var. villosa	Black Rolypoly
Selliera radicans	
Senecio diaschides	
Senecio hispidulus var. hispidulus	Rough Groundsel
Senecio lautus (including ssp. dissectifolius)	
Senecio linearifolius	
Senecio minimus	
Senecio quadridentatus	
Smilax glyciphylla	Smilax
Solenogyne dominii	
Spirodela species	Duck Weed
Sporobolus diander	
Sporobolus elongatus	
Sporobolus virginicus	Sand Couch
Stackhousia monogyna	
Stackhousia viminea	
Stipa pubescens	Speargrass

Species name	Common name
Stipa rudis ssp. nervosa	Speargrass
Stipa rudis ssp. rudis	Speargrass
Stylidium graminifolium	Trigger Plant
Styphelia triflora	Five-corners
Styphelia tubiflora	
Suaeda australis	
Syncarpia glomulifera	Turpentine
Syzygium paniculatum	Magenta Lillypilly
Tetragonia tetragonioides	Warrigal Greens
Thelymitra pauciflora	Slender Sun Orchid
Themeda australis	Kangaroo Grass
Todea barbara	King Fern
Trachymene incisa ssp. incisa	
Trema aspera	Native Peach
Triglochin procerum (now Triglochin microtuberosum and Triglochin rheophilum)	Water Ribbons
Triglochin striatum	Water Ribbons
Tristaniopsis laurina	Water Gum
Tylophora barbata	
Typha orientalis	Bullrush

Species name	Common name
Velleia lyrata	
Vernonia cinerea var. cinerea	
Veronica calycina	Speedwell
Veronica plebeia	Speedwell
Viminaria juncea	Golden Spray
Viola hederacea	Native Violet
Wahlenbergia gracilis	Native Bluebell
Wahlenbergia littoricola	Native Bluebell
Wahlenbergia multicaulis	Native Bluebell
Wahlenbergia stricta	Native Bluebell
Wilsonia backhousei	
Xanthorrhoea arborea	Grass-tree
Xanthorrhoea media	Grass-tree
Xanthorrhoea resinifera (syn. Xanthorrhoea resinosa)	Grass-tree
Xanthosia pilosa	
Xanthosia tridentata	
Xylomelum pyriforme	Woody Pear
Zieria pilosa	
Zieria smithii	
Zornia dyctiocarpa var. dyctiocarpa	
Zoysia macrantha (syn. Zoysia pungens)	Coast Couch

Appendix F

Key Powers for Councils under the Protection of Environment and Operations Act

KEY POWERS FOR COUNCIL UNDER THE PROTECTION OF THE ENVIRONMENT AND OPERATIONS ACT IN RELATION TO STORMWATER MANAGEMENT AND POLLUTION

(source: Report submitted to Finance and General Committee for Rockdale Council on 4/11/98)

Process	Circumstances	Budgetary considerations (values are subject to State regulation)	Penalty Provisions
Section 91 Clean up Notice	Can be served in writing or orally by Council when a pollution incident has occurred or is occurring or is likely to occur. This notice cannot be used in relation to odours or noise.	$320 administration fee payable to Council as a consequence of the service of the Notice.	$500 Penalty Infringement Notice for Individuals. $1000 Penalty Infringement Notice for Corporations should the administration fee not be paid on time.
		A compliance cost Notice can be served by Council to recover all of its reasonable costs to monitor compliance or carry out the clean up itself.	Unpaid compliance costs can be recovered as a debt and registered as a charge against property owner by the person or corporation is question.
		Failure to comply with the terms of the Clean up Notice.	$750 Penalty Infringement Notice for Individuals $1500 Penalty Infringement Notice for Corporations or Legal Action with maximum penalties of $250,000 (corporation) $120,000 (individual) plus the liability to a daily penalty.

Process	Circumstances	Budgetary considerations (values are subject to State regulation)	Penalty Provisions
Section 96 Prevention Notice (includes noise and odour emission)	Can be served by Council in respect of an activity that has been, or is being conducted in an environmentally unsatisfactory manner. Such Notices can be very comprehensive in their nature even requiring such actions as the recipient to prepare a plan of action to control, prevent or minimisation of pollution or waste.	$320 administration fee payable to Council as a consequence of the service of the Notice	$500 Penalty Infringement Notice for Individuals. $1000 Penalty Infringement Notice for Corporations should the administration fee not be paid on time.
		A compliance cost can be served by Council to recover all of its reasonable costs to monitor compliance or carry out the clean up itself.	Unpaid compliance costs can be recovered as a debt and registered as a charge against property owner by the person or corporation is question.
		Failure to comply with the terms of a Prevention Notice	$750 Penalty Infringement Notice for Individuals $1500 Penalty Infringement Notice for Corporations or Legal Action with maximum penalties of $250,000 (corporation) $120,000 (individual) plus the liability to a daily penalty.

Process	Circumstances	Budgetary considerations (values are subject to State regulation)	Penalty Provisions
Powers of Entry to Premises by Council-authorised Officers (Parts 4.6 and 7.4)	The authorised officer can enter commercial, industrial and agricultural premises whilst the activity is being carried out or at any time when pollution is suspected. Advance notice is not required. This does not apply to residential premises.		Maximum penalties for obstruction of authorised persons: $250,000 (corporation) $120,000 (individual) plus the liability to a daily penalty.
Power for Council to take legal precedings for Tier 1 offences currently only available to the EPA	There are three tiers of offences, Tier 1 being the most serious level of offences, Tier 2 are other offences and Tier 3 are the more minor offences where the on the spot penalties are warranted		Land and Environment Court or the Supreme Court $1,000,000 (corporation) $250,000 (individual and/or 7 years imprisonment for an individual
Increases in certain on-the-spot fines (Penalty Infringement Notices) and the creation of new fines	Polluting waters		currently $600 Proposed $750 (individual) $1500 (corporation)
	Cause air pollution		$750 (individual) $1,500 (corporation)
	Using land unlawfully for waste (nor littering)		$750 (individual) $1,500 (corporation)
	Littering for a motor vehicle		$200 (individual) $400 (corporation)
Power to obtain information for the purposes of the POEO Act	An authorised officer can require a person to answer questions that based on a reasonable suspicion, the officer suspects to have knowledge, for example, about a pollution incident		Maximum penalty $11,000

Appendix G

Table 7.1 Evaluation of Options for Stormwater Management

					COSTS				BENEFITS							RANK		
Action No.	Waterway	Authority	Option Type	Description	Installation	10 Year Operating	Total Installation + 10 Year operating Cost	Cost Index	Target Pollutant	No. Pollutants	Rel Impacts of Pollutants in Cooks River	%of Catchment benefited	Effectiveness	Education Value	Education Value No.	Benefit Index	Cost/Benefit Ratio	Rank
				Litter														
7	ALL	EDDept	ED	Develop an education and awareness program in schools, in cooperation with the Department of Education	$2,000	$20,000	$22,000	1	Litter	7	6	100%	med	high	10	6.6667	1.5	2
5	ALL	ALL-C	ED	Develop and implement sinage in public areas to provide feedback on improvements in stormwater quality through information of stormwater treatment measures. Pollutant loading measures could be regularly updated.	$20,000	$30,000	$50,000	1	Litter	7	6	40%	med-high	high	10	6	1.6667	6
15	ALL	ALL - C	MAN	Influence state government to introduce legislation to require manufacturers to reduce packaging and provide return fees for recyclables (eg. container deposits, and waste oil) .	$2,000	$20,000	$22,000	1	Litter	1	6	100%	high	med-low	3	5.3333	1.875	14
14	ALL	ALL	MAN	Provide stickers "NO JUNK MAIL - We're protecting the Cooks River Catchment" in Council Rate Notices.	$13,000	$0	$13,000	1	Litter	1	6	80%	med	med-high	7	5	2	19
4	ALL	ALL-C	ED	Trial park areas by removing bins and providing signage "Thank You for caring for the park and the Cooks River". Monitor success of the trial bin removal project and implement appropriate strategy for ALL park areas within the catchment.	$8,000	$0	$8,000	1	Litter	1	6	10%	med	high	10	4.1667	2.4000	28
12	ALL	ALL	MAN	Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	$13,000	$0	$13,000	1	Litter	1	6	20%	med-high	med-high	7	4.1667	2.4	29

					COSTS				BENEFITS							RANK		
Action No.	Waterway	Authority	Option Type	Description	Installation	10 Year Operating	Total Installation + 10 Year operating Cost	Cost Index	Target Pollutant	No. Pollutants	Rel Impacts of Pollutants in Cooks River	%of Catchment benefited	Effectiveness	Education Value	Education Value No.	Benefit Index	Cost/Benefit Ratio	Rank
9	ALL	ALL	MAN	Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	$13,000	$0	$13,000	1	Litter	1	6	20%	med-high	med	5	3.8333	2.6087	36
2	ALL	ALL	ED	Support anti-Litter education campaigns at a local level through signage and local education. eg. Clean -Up Australia Day, The Drain is Just for Rain, Streets to rivers project, Cooks River Valley Association street clean up project.	$26,000	$130,000	$156,000	3	Litter	7	6	100%	med	high	10	6.6667	4.5	54
1	ALL	ALL	ED	Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	$8,000	$100,000	$108,000	3	Litter	7	6	60%	med-high	high	10	6.3333	4.7368	55
6	ALL	ALL - C	ED	Support EPA "dob in a dumper" hotline through advertising within the Cooks River catchment.	$2,000	$150,000	$152,000	3	Litter	2	6	100%	med-high	high	10	6.1667	4.8649	57
13	ALL	ALL	MAN	Target regular users of parks adjacent to river eg. sporting clubs. Make the clubs responsibile for leaving the area free of Litter after use of the facilities. Use leasing or hire arrangements to implement a cleanup charge for areas left in an unsatifactory state.	$7,800	$65,000	$72,800	2	Litter	1	6	5%	med-high	med-high	7	4	5	58
10	ALL	ALL	MAN	Upgrade recycling bins which perform poorly by investigating alternative bins, in conjunction with the Inner Sydney Waste Board.	$26,000	$130,000	$156,000	3	Litter	1	6	80%	med-high	Med-High	7	5.1667	5.8065	76
8	ALL	ALL	EN	Warn and fine people littering in accordance withEPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	$2,000	$260,000	$262,000	4	Litter	1	6	20%	med	high	10	4.3333	9.2308	111
141	ALL	ALL	MAN/ED	Investigate demand for recycling bins at parks.	$50,000	$200,000	$250,000	4	Litter	1	6	10%	med	med-high	7	3.6667	10.909	121

					COSTS				BENEFITS							RANK		
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11	ALL	ALL	MAN	Continue existing dry street sweeping of commercial, industrial and residential areas, including carparks.	$0	$15,000,000	$15,000,000	10	Litter	4	6	75%	med-high	med	5	5.3333	18.75	149
3	ALL	ALL	MAN	Investigate if mixed and recyclable waste removal frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	$10,000	$1,500,000	$1,510,000	8	Litter	1	6	80%	med	med-low	3	4.1667	19.2	150
16	ALL	All	ST	Install trapped street gully pits at selected locations throughout the catchment along roads and provide regular maintenance.	$ 650,000	$1,500,000	$2,150,000	8	Litter	3	6	60%	medium	low	1	3.8333	20.87	151
				HOT SPOTS												0		
166	MU	SW	ST	Install floating boom at Muddy Creek downstream of Bestic St bridge, Muddy Creek	$35,000	$100,000	$135,000	1	Litter	1	6	6%	low	med-high	7	3.6667	2.7273	39
23	CO	CANT	ST	Maintain existing pollutec pollutant trap at the park near Belmore Rugby League field	$ -	$100,000	$100,000	2	Litter	3	6	5%	medium	med-high	7	4	5	59
42	WO	HUR	ST	Incorporate litter & erosion controls into redevelopment of site upstream of King Georges Rd, Hurstville by developer	$ 30,000	$30,000	$60,000	2	Litter	1	6	3%	medium	med-low	3	3	6.6667	82
43	MUNNI	MAR	ST	Install gross pollutant interceptor at pipe outlet near Thornley St, Marrickville	$ 20,000	$50,000	$70,000	2	Litter	1	6	1%	medium	med-low	3	3	6.6667	83
154	BA	ROC	ST	Provide minor gross pollutant trap to end of pipe discharging to Bardwell Creek near Bardwell Rd	$ 30,000	$50,000	$80,000	2	Litter	3	6	4%	medium	low	1	3	6.6667	84
37	Omaha	CANT	ST	Provide buffer strips behind embankment walls of channel at Rudd Park, Belfield where necessary.	$ 15,000	$50,000	$65,000	2	Litter	1	6	2%	medium	low	1	2.6667	7.5	92
44	CO	MAR	ST	Retrofit pit litter baskets at selected sites Hercules St area, Dulwich Hill	$ 10,000	$50,000	$60,000	2	Litter	1	6	2%	medium	low	1	2.6667	7.5	93
45	AC	RAN	ST	Install pit litter baskets in area near the Australian Golf Club where appropriate	$ 10,000	$50,000	$60,000	2	Litter	1	6	1%	medium	low	1	2.6667	7.5	94
27	BA	ROC	ST	Provide coarse trash rack along Bardwell Creek near Ellerslie Rd, Bexley North to protect the downstream bushland	$ 30,000	$100,000	$130,000	3	Litter	2	6	5%	medium	med-high	7	3.8333	7.8261	101

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21	UP	BANK	ST	Maintain existing trash rack at Muir Rd, Chullora	$ -	$200,000	$200,000	3	Litter	1	6	5%	medium	med-high	7	3.6667	8.1818	104
22	CO	CANT	ST	Repair and maintain floating boom along Cooks River at Fifth Ave, Campsie	$ 10,000	$100,000	$110,000	3	Litter	1	6	5%	medium	med-high	7	3.6667	8.1818	105
24	MUNNI	MAR	ST	Install pollutant trap at Tennyson St subcatchment	$ -	$150,000	$150,000	3	Litter	1	6	5%	medium	med-high	7	3.6667	8.1818	106
150	BA	ROC	ST	Provide GPT along Bardwell Creek downstream of Preddys Road, Bexley North	100,000	$100,000	$200,000	3	Litter	1	6	4%	medium	medium	5	3.3333	9	110
41	Rookwood	SW/BLG	ST	Maintain GPT and construct wetland in redevelopment of SRA land at Chullora Rail Workshops and provide maintenance.	$ 250,000	$250,000	$500,000	5	Litter	4	6	4%	high	med-high	7	5	10	114
175	CO	SW	ST	Maintain existing GPT at Orissa Drain, Fifth Avenue Campsie.	$ -	$343,000	$343,000	4	Litter	2	6	5%	med	med-high	7	3.8333	10.435	120
176	MUNNI	SW	ST	Maintain existing GPT and drainage pumping station/detention basin at the Brickpit, Railway Road, Sydenham.	$ -	$900,000	$900,000	4	Litter	1	6	5%	medium	med-high	7	3.6667	10.909	122
39	CO	CANT	ST	Install and maintain proposed GPT at Tasker Park, Campsie	$ 150,000	$150,000	$300,000	4	Litter	3	6	2%	medium	medium	5	3.6667	10.909	123
171	UC	SW	ST	Investigate feasibility and provide GPT along Cooks River at Verona St, Strathfield South	$200,000	$150,000	$350,000	4	Litter	2	6	15%	medium	medium	5	3.6667	10.909	124
33	Mascot	SW	ST	Provide gross pollutant interceptor/GPT near pipe end of Mascot West SWS	$ 100,000	$ 150,000	$250,000	3	Litter	1	6	2%	medium	low	1	2.6667	11.25	126
36	Munni	SW	ST	Provide gross pollutant interceptor near pipe outlet of Munni SWS upstreanm of proposed dechannelisation works.	$ 200,000	$ 150,000	$350,000	3	Litter	1	6	2%	medium	low	1	2.6667	11.25	127
159	CS	CANT	ST	Provide pit litter baskets at selected locations in Campsie industrial area within Cup and Saucer Creek catchment.	$10,000	$100,000	$110,000	3	Litter	1	6	3%	medium	low	1	2.6667	11.25	128
172	UC	STRA	ST	Provide Litter baskets at Cosgrove Road/ Madeline St industrial area	$15,000	$100,000	$115,000	3	Litter	1	6	1%	medium	low	1	2.6667	11.25	129
179	Orissa	CANT	ST	Retrofit litter baskets/silt traps at selected pits in Orissa St subcatchment, Campsie	10,000	$100,000	$110,000	3	Litter	1	6	1%	medium	low	1	2.6667	11.25	130
170	UC	SW / STRA	ST	Provide GPT along Cooks River near Cleveland St, Strathfield South	$200,000	$200,000	$400,000	4	Litter	2	6	15%	medium	medium	5	3.5	11.429	131

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40	Greenacre Park	SW/ BANK	ST	Provide GPT/wetland downstream of Hume Highway along Greenacre Park SWS	$ 250,000	$250,000	$500,000	5	Litter	4	6	4%	med-high	medium	5	4.1667	12	132
151	BA	ROC	ST	Provide pit litter baskets at selected locations within Bardwell Creek catchment.	100,000	$100,000	$200,000	3	Litter	1	6	6%	med-low	low	1	2.3333	12.857	134
20	MUNNI	SW	ST	Maintain existing trash rack at Mackey Park, Marrickville	$ -	$400,000	$400,000	5	Litter	2	6	5%	medium	med-high	7	3.8333	13.043	135
28	Botany	SW	ST	Provide gross pollutant trap/interceptor near Botany Rd SWS pipe end	$ 250,000	$250,000	$500,000	4	Litter	3	6	3%	medium	low	1	3	13.333	136
30	CS	SW/CANT	ST	Provide gross pollutant interceptors at pipe outlets (approx. 3) to Cup and Saucer Creek at industrial area near Alfred St, Campsie	$ 75,000	$200,000	$275,000	4	Litter	1	6	4%	medium	med-low	3	3	13.333	137
155	CO	MAR	ST	Install gross pollutant traps before pipe outlets (approx. 2) to Cooks River at HJ Mahoney Memorial Reserve, Marrickville South	100,000	$300,000	$400,000	4	Litter	2	6	2%	medium	low	1	2.8333	14.118	139
19	CS	SW	ST	Maintain existing trash rack at Cup & Saucer Creek, Canterbury	$ -	$640,000	$640,000	6	Litter	2	6	5%	medium	med-high	7	3.8333	15.652	145
18	WO	SW	ST	Maintain existing GPT at Wolli Creek, Kingsgrove	$ -	$900,000	$900,000	7	Litter	3	6	10%	medium	med-high	7	4	17.5	146
31	CX	SW	ST	Provide gross pollutant traps on pipe outlets (approx. 3) to Cox's Creek near King Georges Rd, Greenacre	$ 150,000	$300,000	$450,000	5	Litter	2	6	3%	medium	low	1	2.8333	17.647	147
				NUTRIENTS AND BACTERIA														
143	ALL	ALL	MAN	Introduce a planning policy to ensure that adequate facilities are provided for new developments, including units, residential, commercial and industrial.	$7,800	$0	$7,800	1	Nutrients	5	5	80%	med-high	med-low	3	5.3333	1.875	15
57	ALL	ALL - C	MAN	Support and encourage prioritisation for upgrade of sewerage infrastructure within the catchment as identified by Sydney Water's Priority Actions (SOLP).	$1,000	$0	$1,000	1	Bacteria	2	5	100%	med-high	low	3	5.3333	1.875	16
54	ALL	ALL- C	MAN	Identify appropriate procedures to manage blue green algal blooms.	$3,000	$20,000	$23,000	1	Toxicants	2	8	20%	med-high	low	3	5	2	20

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49	ALL	ALL	ED	Provide doggie dunnit bags/stations at selected parks.	$2,000	$20,000	$22,000	1	Bacteria	2	5	20%	med	high	10	4.8333	2.069	22
55	ALL	ALL-C	MAN	Introduce requirement for inspection of sewer and stormwater connections into section 176 certification required for all residential and commercial property sales.	$13,000	$0	$13,000	1	Bacteria	1	5	100%	med	low	1	4.5	2.2222	25
47	ALL	ALL-C	MAN	Influence state government to investigate alternatives to phosphorus use in detergents and reconsider sodium chloride (salt) levels.	$2,000	$0	$2,000	1	Nutrients	1	5	100%	med	low	1	4.3333	2.3077	26
142	ALL	ALL-C	MAN	Investigate the feasibility of introducing dung beetles to replace fertiliser use in council Park areas. (Note Strathfield Council currently trialling)	$15,000	$0	$15,000	1	Bacteria	2	5	10%	med	low	1	3.1667	3.1579	43
53	ALL	ALL	MAN	Replace fertiliser use with worms or reuse captured stormwater which may be high in nutrients. Based on ongoing trial into effectiveness by Marrickville Council.	$20,000	$0	$20,000	1	Nutrients	1	5	10%	med	med-low	3	3.1667	3.1579	44
50	ALL	ALL	ED	Education and enforcement of council maintenance crews and gardeners to pick up grass clipping from mowing of maintenance strips and parks.	$26,000	$130,000	$156,000	2	Organic	3	7	20%	med-high	med	5	5.1667	3.871	51
149	ALL	ALL	ED	Educate the community not to sweep or blow leaves into the gutter.	$30,000	$75,000	$105,000	3	Organic	1	7	80%	med	high	10	6.3333	4.7368	56
51	ALL	ALL - C	ED	Educate the community to prevent car washing on the street .	$30,000	$75,000	$105,000	3	Nutrients	1	5	100%	med	high	10	5.8333	5.1429	70
48	ALL	ALL	ED	Negotiate with local car washing places for first visit free coupons to encourage use of carwash centres. Focus on high residential areas with little or no alternatives. Incorporate an education component with the distribution of coupons	$5,000	$50,000	$55,000	2	Nutrients	1	5	10%	med	med- high	7	3.8333	5.2174	71

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52	ALL	ALL	EN	Control dog droppings by implementing Companion Requirements.	$13,000	$130,000	$143,000	3	Bacteria	2	5	20%	med	high	10	4.8333	6.2069	79
58	ALL	ALL- C	MAN/EN	Policy requiring car washing facilitiesto be connected to sewer for units. Need to then distribute and enforce.	$26,000	$130,000	$156,000	3	Nutrients	1	5	2%	med-high	med-low	3	3.5	8.5714	107
144	ALL	MAR, CANT BANK,	ST/ED	Provide public car wash areas connected to sewer or a suitable alternative. Also provide signs to educate people about carwashing in the streets.	$60,000	$300,000	$360,000	4	Nutrients	2	5	10%	med	med-high	7	4	10	115
56	ALL	ALL	ED	Educate residents about overfertilisation. Develop and distribute an information brochure.	$30,000	$75,000	$105,000	5	Nutrients	1	5	20%	med	med-low	3	3.3333	15	143
				HOT SPOTS														
63	CO	SW	ST	Sydney Water to ensure that investigations are carried out to determine the cause of the sewer overflow problem at crn of Homer Street and Illawarra Road and Undercliffe Road roundabout. Ensure this action is included in the SOLP action plan.	$2,000	$0	$2,000	1	Bacteria	3	5	5%	high	low	1	4.1667	2.4	30
64		? SW	ST	Sydney Water to ensure that investigations are carried out to determine the cause of the sewage smell, a possible leak near sugar mill site. Ensure action is included in the SOLP action plan.	$2,000	$0	$2,000	1	Bacteria	3	5	3%	high	low	1	4.1667	2.4	31
67	WO	SW	ST	Sydney Water to ensure that investigations are carried out to determine the cause of the sewer leaks in Girraween Park. Manholes always overflow after rainfall . Ensure action is included in the SOLP action plan.	$10,000	$0	$10,000	1	Bacteria	3	5	3%	high	low	1	4.1667	2.4	32
60	ALL	ALL	ST	Feasibility study to install wetlands at Golf Courses.	$25,000	$0	$25,000	1	Nutrients	3	5	15%	med	med	5	4	2.5	34
61	UC	STRA	ST	Construct urban stream at Strathfield Golf Course/Freshwater Park	$ 200,000	$100,000	$300,000	4	Nutrients	4	5	15%	high	high	10	5.8333	6.8571	88

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152	BA	ROC	ST	Construct wetland along Bardwell Creek downstream of Ellierslie Road	250,000	$150,000	$400,000	4	Nutrients	3	5	5%	high	high	10	5.5	7.2727	91
160	CS	SW/CANT	ST	Provide esturine wetland at Heynes Reserve, Canterbury on Cup and Saucer Creek	$150,000	$150,000	$300,000	4	Nutrients	4	5	2%	med-high	high	10	5.1667	7.7419	97
162	CX	SW/STRATH	ST	Construct wetland along Cox's Creek at Begnell Park, Belfield. Consider in SRA land upstream of Cosgrave Road in Enfield Marshalling Yards.	$250,000	$250,000	$500,000	4	Nutrients	4	5	9%	med-high	high	10	5.1667	7.7419	98
164	MU	SW/ROC	ST	Construct wetlands along Muddy Creek at reserve on Bestic St and White Oak Reserve	$250,000	$250,000	$500,000	4	Nutrients	4	5	6%	med-high	high	10	5.1667	7.7419	99
167	Omaha	SW/cant	ST	Construct offline wetland upstream of tidal limit on Omaha Canal	$200,000	$200,000	$400,000	4	Nutrients	4	5	5%	med-high	high	10	5.1667	7.7419	100
177	CO	CANT	ST	Install backwash storage tanks and dispose of backwash from Roselands and Cantebury Pools to sewer.	$60,000	$50,000	$110,000	3	Nutrients	2	5	1%	high	low	1	3.8333	7.8261	102
62	CS	SW/CANT	ST	Provide wet detention basins along creek at Hughes Park	$ 150,000	$150,000	$300,000	4	Nutrients	4	5	4%	med-high	medium	5	4.3333	9.2308	112
65	WO	ROC	ST	Develop wetland as part of the proposed NPWS regional park in lower Wolli Creek area	$ 500,000	$200,000	$700,000	6	Nutrients	4	5	12%	high	high	10	5.8333	10.286	118
66	AC	SW	ST	Trial wetlands as proposed in Alexandra Canal Water Environment Plan from Sydney Park to Canal Rd, St Peters.	$3,000,000	$20,000	$3,020,000	8	Nutrients	4	5	15%	high	high	10	5.8333	13.714	138
				TOXICANTS (including heavy metals, herbicides, pesticides, oil and grease)														
145	ALL	ALL,SW, Rail,RTA	MAN	In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	$20,000	$12,000	$32,000	1	Weeds	6	8	10%	med-high	med	5	5.5	1.8182	11
73	ALL	ALL- C	MAN	Lobby EPA to audit all licensed premises in the catchment.	$1,000	$0	$1,000	1	Sediments	8	5	5%	med-high	med	5	5	2	21

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70	ALL	ALL	AU/ED	Education/ Training /Auditing of businesses through application of the knowledge gained through the solutions to pollution campaign and auditing undertaken throughout the catchment.	$30,000	$300,000	$330,000	4	Toxicants	5	8	30%	med-high	med-high	7	6.3333	6.3158	81
74	ALL	ALL - C	MAN	Develop and implement a water quality monitoring program, database and reporting system.	$60,000	$600,000	$660,000	6	Toxicants	8	8	100%	high	high	10	9	6.6667	85
69	ALL	ALL, EPA	AU	Initiate increased auditing of non-EPA licenced industrial and commercial premises by Council Officers.	$67,600	$676,000	$743,600	6	Toxicants	3	8	15%	med-high	med-high	7	5.8333	10.286	119
				HOT SPOTS														
78	CS	CANT	ST	Investigate need for site remediation and leachate control at Harp St brick pit, Campsie	25,000	$0	$25,000	1	Toxicants	1	8	1%	high	medium	5	5.5	1.8182	12
76	AC	MAR	ST	Remediation of Tempe Reserve landfill area to prevent off site leachate of contaminants.	$100,000	$100,000	$200,000	3	Toxicants	3	8	15%	high	med	5	6	5	60
77	ALL	All	ST	Encourage the installation of OSD where feasible within industrial sites	20,000	$100,000	$120,000	3	Nutrients	1	5	15%	high	high	10	5.3333	5.625	74
80	ALL	ALL	MAN	Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale or for any new or redevelopments.	$25,000	$250,000	$275,000	4	Toxicants	3	8	25%	med-high	high	10	6.5	6.1538	78
				MANAGERIAL & SOCIAL														
87	ALL	ALL-C	MAN	Establish co-ordinating body to achieve implementation of all catchment based actions. Co-rdinating body to be given appropriate power. Refer to Section 9 of the Plan.	$5,000	$0	$5,000	1	ALL	4	9	100%	med	med	5	6.8333	1.4634	1
90	ALL	ALL-C	MAN	Identify ownership of government land and agree responsibilities between land managers in the catchment.	$5,000	$10,000	$15,000	1	ALL	8	9	20%	med-high	med	5	6.5	1.5385	3

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84	ALL	ALL	MAN	Councils to incorporate detention basins, rainwater collection tanks (where applicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	$26,000	$0	$26,000	1	Sediments	4	5	80%	high	med	5	6	1.6667	7
85	ALL	ALL	MAN	Investigate additional controls for owner/developers who build or pave over more than 50% of land area. Incentives/rebates for those who install stormwater controls.	$13,000	$20,000	$33,000	1	Sediments	4	5	80%	med-high	med-high	7	5.8333	1.7143	9
89	ALL	ALL - C	MAN	Define of responsibilities for clean up within the catchment.	$5,000	$0	$5,000	1	Litter	8	6	100%	med	low	1	5.3333	1.875	17
93	ALL	SW, Rail, DOT, RTA	MAN	State agencies to be consistent with Council planning policies and controls to ensure stormwater management is consistent. To include such developments as the M5motorway, rail workshops etc.	$3,000	$0	$3,000	1	ALL	4	9	5%	med-high	med-low	3	5.3333	1.875	18
86	ALL	ALL	MAN	Investigate opportunites for introduction of a levy collected by the co-ordinating body to fund catchment based actions to be implemented by this body.	$20,000	$50,000	$70,000	2	ALL	4	9	80%	med	med-high	7	6.8333	2.9268	42
82	ALL	ALL	ED	Investigate and develop opportunities for community and businesses which are part of the problem to become part of the solution by becoming involved in stormwater management.	$26,000	$130,000	$156,000	3	ALL	4	9	100%	high	high	10	8.5	3.5294	48
83	ALL	ALL	ED	Implement greater use of ethnic media to reach non-English speaking community. Develop information sheets and use community centres and schools.	$10,000	$50,000	$60,000	2	ALL	4	9	15%	med-low	med-high	7	5.5	3.6364	49
88	ALL	ALL - C	MAN	Integrate Councils knowledge and information base through catchment based water quality monitoring and reporting.	$50,000	$600,000	$650,000	6	Toxicants	8	8	100%	high	high	10	9	6.6667	86
				SUSPENDED SOLIDS														

					COSTS				BENEFITS							RANK		
Action No.	Waterway	Authority	Option Type	Description	Installation	10 Year Operating	Total Installation + 10 Year operating Cost	Cost Index	Target Pollutant	No. Pollutants	Rel Impacts of Pollutants in Cooks River	%of Catchment benefited	Effectiveness	Education Value	Education Value No.	Benefit Index	Cost/Benefit Ratio	Rank
96	ALL	ALL	ED	Adoption of the blue book into all council development approvals and building approvals for construction activities as the preferred best practice techniques to have a consistent approach across the catchment.	$13,000	$0	$13,000	1	Sediments	1	5	10%	med	med-high	7	3.8333	2.6087	37
97	ALL	ALL	ED	Educate occupiers of commercial premises and residences about not hosing down footpath areas. Include in above education and auditing of premises.	$30,000	$150,000	$180,000	3	Sediments	3	5	15%	med	high	10	4.8333	6.2069	80
95	ALL	ALL	ED	Education of construction community through-providing best practice guidelines, eg EPA Solutions to Pollution Booklet, at the devopment approval stage (eg.signs on sediment fences).	$13,000	$130,000	$143,000	3	Sediments	5	5	5%	med-high	med	5	4.5	6.6667	87
98	ALL	ALL	ED/EN	Auditing sediment controls on construction sites for compliance with development approval conditions. Enforced by council officers.	$52,000	$520,000	$572,000	5	Sediments	4	5	5%	high	high	10	5.6667	8.8235	109
100	ALL	ALL	ST	Maintenance and cleaning out of manholes and sediment traps. Ensure Sediments are disposed of appropriately.	$100,000	$1,000,000	$1,100,000	8	Sediments	4	5	10%	high	med-low	3	4.5	17.778	148
99	ALL	ALL	MAN	Implement regular cleaning of drains. Investigate maintenance schedules and cleaning technique and implement improvement program. Ensure Sediments are tested for contamination and disposed on appropriately.	$100,000	$1,000,000	$1,100,000	8	Sediments	2	5	20%	med-high	low	1	3.5	22.857	152
				HOT SPOTS														
105	UC	AUB & BANK & STRA	ST	Investigate and install erosion controls for development immediately upstream of drain at eastern boundary of Rookwood Cemetery and for the channel itself.	$2,000	$0	$2,000	1	Sediments	3	5	1%	med-high	med	5	4.1667	2.4	33

					COSTS				BENEFITS							RANK		
Action No.	Waterway	Authority	Option Type	Description	Installation	10 Year Operating	Total Installation + 10 Year operating Cost	Cost Index	Target Pollutant	No. Pollutants	Rel Impacts of Pollutants in Cooks River	%of Catchment benefited	Effectiveness	Education Value	Education Value No.	Benefit Index	Cost/Benefit Ratio	Rank
103	CO	ALL	ST	Investigate continue dredging of sediments in most severely silted up reaches of the River eg. Third Ave, Campsie. Action should be carried out in accordance with the requirements of NSW State Rivers and Estuaries Policy.	$50,000	$0	$50,000	1	Sediments	3	5	20%	med-high	low	1	3.6667	2.7273	40
161	CS	CANT	ST	Refill eroded ground behind embankment downstream of Fore St, Earlwood	$25,000	$30,000	$55,000	1	Sediments	1	5	1%	high	low	1	3.6667	2.7273	41
109	MUNNI	MAR	ST	Investigate sludge buildup at Mackay Park, Marrickville .	$5,000	$0	$5,000	1	Sediments	3	5	1%	med	low	1	3.1667	3.1579	45
112	BA	ROC	ST	Provide buffer strips at Jubilee Park, Bardwell Park	$30,000	$50,000	$80,000	2	Sediments	2	5	1%	med-high	medium	5	4	5	61
108	WO	HUR	ST	Provide erosion controls where appropriate at the recreation/club site at Forest Rd/King Georges Rd, Hurstville	$30,000	$30,000	$60,000	2	Sediments	1	5	1%	med-high	medium	5	3.8333	5.2174	72
110	AC	SCC	MAN	Develop erosion & sediment control plan for Waste Transfer Station, St Peters	$30,000	$50,000	$80,000	2	Sediments	1	5	1%	med-high	medium	5	3.8333	5.2174	73
114	UC	SRA	MAN	Develop erosion & sediment control plan at Enfield Marshalling Yards. Investigate providing buffer strips and sediment basins at appropriate locations.	$30,000	$150,000	$180,000	3	Sediments	2	5	3%	high	high	10	5.3333	5.625	75
111	AC	MAR	MAN	Develop erosion & sediment control plan for Cooks River Goods Yards, Sydenham	$30,000	$100,000	$130,000	3	Sediments	3	5	1%	med-high	medium	5	4.1667	7.2	89
153	BA	ROC	ST	Provide bank remediation upstream of Bardwell Rd, Bardwell Park	$100,000	$50,000	$150,000	3	Sediments	2	5	4%	high	med-low	3	4.1667	7.2	90
113	UC	SRA	MAN	Develop sediment control plan at Chullora Rail Workshops. Investigate providing buffer strips and sediment basins at appropriate locations.	$20,000	$300,000	$320,000	4	Sediments	2	5	3%	high	high	10	5.3333	7.5	95
115	AC	SRA	MAN	Develop erosion & sediment control plan for Eveleigh Railway Workshops	$30,000	$100,000	$130,000	3	Sediments	2	5	1%	med-high	medium	5	4	7.5	96
157	CO	CANT/MAR	ST	Provide bank stabilisation where appropriate along the Cooks River between Illawarra Rd to Marsh St, Arncliffe	$200,000	$50,000	$250,000	4	Sediments	1	5	30%	high	med-high	7	5	8	103

					COSTS				BENEFITS							RANK		
Action No.	Waterway	Authority	Option Type	Description	Installation	10 Year Operating	Total Installation + 10 Year operating Cost	Cost Index	Target Pollutant	No. Pollutants	Rel Impacts of Pollutants in Cooks River	%of Catchment benefited	Effectiveness	Education Value	Education Value No.	Benefit Index	Cost/Benefit Ratio	Rank
158	CO	CANT/MAR	ST	Provide bank stabilisation along the Cooks River between Church St to Ford Ave, Hurlstone Park	$200,000	$50,000	$250,000	4	Sediments	1	5	10%	high	med-high	7	4.6667	8.5714	108
104	UC	AUB	ST	Provide stream remediation/bank stabilisation along Cooks River downstream of Chullora Rail Workshops to Strathfield Golf Course	200,000	$50,000	$250,000	4	Sediments	1	5	4%	high	medium	5	4.3333	9.2308	113
176	CO	SW	ST	Maintain existing detention pit/drainage pumping station at Carrington Road, Marrickville.	$0	$300,000	$300,000	4	Sediments	4	5	1%	med-high	med-low	3	4	10	116
182	UC	BANK	ST	Install detention basin at Chullora Railway Workshops.	$100,000	$200,000	$300,000	4	Sediments	2	5	3%	med-high	medium	5	3.3333	12	133
183	MUNNI	MAR	ST	Install drainage pumping station /detention pit and silt screen at Mary Road, St Peters.	150,000	$150,000	$300,000	4	Sediments	2	5	5%	medium	med-low	3	2.6667	15	144
				HABITAT LOSS & RIVER HEALTH														
119	ALL	ALL	MAN	Incorporate 10m setbacks from creeklines and 20 m from main river in LEPs to allow reestablishment of a riparian zone	$25,000	$0	$25,000	1	Sediments	3	5	100%	med-high	high	10	6.5	1.5385	4
146	ALL	ALL	MAN	Investigate foreshore areas in Government ownership with potential for restoration of more natural drainage lines.	$13,000	$0	$13,000	1	Sediments	5	5	30%	high	high	10	6.1667	1.6216	5
120	ALL	ALL	MAN	Incorporate, preservation of existing natural drainage lines and creeks within Council planning policies and development controls.	$10,000	$50,000	$60,000	1	Sediments	5	5	15%	high	high	10	6	1.6667	8
121	ALL	ALL	MAN	Investigate incorporation of propagation programs for native riparian vegetation in council nurseries.	$10,000	$20,000	$30,000	1	Sediments	5	5	30%	med-high	high	10	5.6667	1.7647	10
147	ALL	ALL	ED	Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	$13,000	$0	$13,000	1	Nutrients	3	5	5%	med	high	10	4.6667	2.1429	24
148	ALL	ALL-C	MAN	Develop a catchment policy for landscaping along foreshore and waterways and incorporate in planning controls using native species.	$8,000	$0	$8,000	1	Nutrients	4	5	5%	med-high	med	5	4.3333	2.3077	27

					COSTS				BENEFITS							RANK		
Action No.	Waterway	Authority	Option Type	Description	Installation	10 Year Operating	Total Installation + 10 Year operating Cost	Cost Index	Target Pollutant	No. Pollutants	Rel Impacts of Pollutants in Cooks River	%of Catchment benefited	Effectiveness	Education Value	Education Value No.	Benefit Index	Cost/Benefit Ratio	Rank
124	ALL	ALL-C, Fisheries	MAN	Prepare a Mangrove Management Plan for the catchment to identify areas for regeneration either via natural colonisation or habitat generation and areas where mangroves are removed to prevent flooding. Comply with NSW State Rivers and Estuaries Policy.	$10,000	$0	$10,000	1	Weeds	4	5	20%	med	med-low	3	4	2.5	35
125	ALL	ALL - C, CMC, Greening Australia	MAN	Identify all areas to be retained and revegetated. Set up a register and body to support and co-ordinate the revegetation and enhancement plans of all local bushcare groups.	$5,000	$0	$5,000	1	Weeds	1	5	10%	med	med-high	7	3.8333	2.6087	38
				HOT SPOTS														
135	Munni	SW	ST	Investigate the dechannelisation between the head of Alexandra Canal and Green Square of lower Sheas Creek as proposed in Alexandra Canal Water Management Plan.	$10,000	$0	$10,000	1	Sediments	2	5	5%	high	high	10	5.5	1.8182	13
169	UC	SW/STRA	ST	Naturalise concrete channel by placing rock and planting native vegetation at Chain of Ponds reserve area. Little or not space available in this area. Investigate alternatives.	$100,000	$30,000	$130,000	1	Natural Habitats	1	5	1%	medium	medium	5	3	3.3333	46
181			ST	Investigate condition of sheet piling along Cooks River, between the Undercliff Bridge and the footbridge at Flinders Road and identify opportunities for naturalising the banks.	$2,000	$0	$2,000	1	Sediments	2	5	1%	medium	med Low	3	3	3.3333	47
184	ALL	ALL	MAN	Councils not currently mapping stormwater infrastructure to do so.	$13,000	$130,000	$143,000	3	ALL	9	8	100%	high	high	10	7.8333	3.8298	50
128		ALL	ST	Enhancement of existing wetland along Wolli Creek, consistent with NSW Wetlands Policy.	$30,000	$50,000	$80,000	2	Nutrients	3	5	5%	med-high	high	10	5	4	52
168	UC	STRA	ST	Provide river bank stabilisation and revegetation at Freshwater Park	$100,000	$30,000	$130,000	2	Sediments	1	5	15%	high	high	10	4.8333	4.1379	53
127			ST	Protection of remnant species of Turpentine and Grey Myrtle in Maria Reserve.	$5,000	$50,000	$55,000	2	Sediments	2	5	1%	low	high	10	4	5	62

					COSTS				BENEFITS							RANK		
Action No.	Waterway	Authority	Option Type	Description	Installation	10 Year Operating	Total Installation + 10 Year operating Cost	Cost Index	Target Pollutant	No. Pollutants	Rel Impacts of Pollutants in Cooks River	%of Catchment benefited	Effectiveness	Education Value	Education Value No.	Benefit Index	Cost/Benefit Ratio	Rank
129		BANK & SRA	ST	Protect Freshwater Creek at Old Chullora Railway Workshops during redevelopment of the Chullora Site. Investigate current planning controls for the area. Look at protecting from further disturbance and continue work with Bankstown Bushland Soc.	$5,000	$50,000	$55,000	2	Sediments	2	5	1%	low	high	10	4	5	63
130		CANT & ROC & HUR	ST	Protect and enhance Wolli Creek Mangroves and Saltmarsh through planning policies and bushcare regeneration programs. Investigate measures to minimise sedimentation and disturbance from railways.	$5,000	$50,000	$55,000	2	Sediments	2	5	1%	low	high	10	4	5	64
131		CANT & SW & RTA	ST	Protection and preservation of Third Ave Remnant bushland, Campsie. Protect through planning policies.	$5,000	$50,000	$55,000	2	Sediments	2	5	1%	low	high	10	4	5	65
132		MAR	ST	Protection of remnant Marrickville Foreshore Reserves.	$5,000	$50,000	$55,000	2	Sediments	2	5	1%	low	high	10	4	5	66
133		MAR, ROC, CANT	ST	Protection of Cooks River Mangroves, Saltmarsh and Rushland areas through Canterbury LGA and incorporate in mangrove management plan.	$5,000	$50,000	$55,000	2	Sediments	2	5	1%	low	high	10	4	5	67
134		Rail, ALL	ST	Protection of Cooks River Clay Plains Scrub Forest within proposed redevelopment site at Rail Yards.	$5,000	$50,000	$55,000	2	Sediments	2	5	1%	low	high	10	4	5	68
137	WC	?	ST	Undertake bush regeneration and protection works on remnant vegetation along Wolli Creek from Bexley north-eastwards.	$5,000	$50,000	$55,000	2	Sediments	2	5	1%	low	high	10	4	5	69
165	MU	SW	ST	Replace concrete embankment along Muddy Creek near White Oak Reserve with rock/vegetation and link to the adjacent reserve.	$200,000	$50,000	$250,000	2	Natural Habitats	1	5	6%	medium	med-high	7	3.3333	6	77

					COSTS				BENEFITS							RANK		
Action No.	Waterway	Authority	Option Type	Description	Installation	10 Year Operating	Total Installation + 10 Year operating Cost	Cost Index	Target Pollutant	No. Pollutants	Rel Impacts of Pollutants in Cooks River	%of Catchment benefited	Effectiveness	Education Value	Education Value No.	Benefit Index	Cost/Benefit Ratio	Rank
138		?	ST	Selectively replace steel sheet piling along Cooks River banks between Church St, Canterbury and Illawarra Rd, Undercliffe using rock embankment/natural vegetation, following a feasibility study.	250,000	$100,000	$350,000	4	Natural Habitats	1	5	30%	medium	medium	5	4	10	117
180	CX	SW/CANT	ST	Naturalise concrete channel by placing rock and planting native vegetation at Parry Park.	150,000	$50,000	$200,000	4	Natural Habitats	1	5	1%	medium	medium	5	3.6667	10.909	125
136	AC	SW	ST	Narrow Alexandra Canal with islands and bank extensions from Canal Rd as proposed in Alexandra Canal Water Management Plan.	$2,000,000	$20,000	$2,020,000	8	Sediments	2	5	15%	high	high	10	5.6667	14.118	141
178	AC	SW	ST	Dechannel 250m section of stormwater channel between the head of Alexandra Canal and Sydney Park as proposed in Alexandra Canal Water Management Plan.	$1,000,000	$10,000	$1,010,000	8	Natural Habitats	1	5	15%	high	high	10	5.5	14.545	142

Appendix H

Table 9 Stormwater Management Implementation Strategy

Table 9.1a: Stormwater Management Implementation Strategy – Association of Councils (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
1.1 Develop an education and awareness program in schools, in cooperation with the Department of Education to link littering with impacts on the waterway.	2*	$2,000	$2,000	0	$2,000	0	$2,000	0	$2,000
1.2 Develop and construct educational signs in public areas, in particular along waterways adjacent to stormwater control facilities, to provide information and feedback on the status and improvements in stormwater quality and projects being undertaken to improve water quality eg. signs next to a litter boom can report on the volume of litter collected each month and show improvements over time.	6*	$20,000	$2,000	0	$2,000	0	$2,000	0	$2,000
3.1 Influence State Government to introduce legislation to require manufacturers to reduce packaging and provide return fees for recyclables (for example, container deposits, and waste oil).	14	0	0	$2,000	$2,000	0	0	0	0
1.3 Support anti-Litter education campaigns at a local level through signage and local education. eg. Clean -Up Australia Day, The Drain is Just for Rain, Streets to rivers project, Cooks River Valley Association garbage and gutters street clean up projects.	57*	0	0	0	0	$26,000	$13,000	0	$13,000
2.1 Support EPA "dob in a dumper" hotline through advertising within Cooks River catchment.	60*	0	0	0	0	0	0	$2,000	$15,000
NUTRIENTS AND BACTERIA									
12.1 Identify appropriate response procedures to manage blue green algal blooms.	20	0	0	0	0	0	0	0	0
8.2 Influence state government to investigate alternatives to phosphorus use in detergents.	26	0	0	$2,000	0	0	0	0	0
11.3 Incorporate in planning controls a requirement for future Golf Course developments to incorporate nutrient management controls.	42*	$3,000	$2,000	0	0	0	0	0	0
8.3 Educate the community to prevent car washing on the street. In residential areas, where there is no alternative, provide an incentive by negotiating with local car washing places for first visit free coupons to encourage use of carwash centres.	73*	0	0	0	0	$30,000	$7,500	0	$7,500
11.2 Educate residents about over fertilising by developing and distributing an information brochure.	148*	0	0	0	0	$30,000	$7,500	0	0
TOXICANTS									
14.1 Lobby EPA to audit all licensed premises in the catchment.	21	$1,000	0	0	0	0	0	0	0
14.2 Education/Training/Auditing of small industrial premises and businesses through expansion of past solutions to pollution, education and auditing programs. Target metal premises, motor vehicle repairers and chemical manufacturers as a priority.	84*	0	0	0	0	$30,000	$30,000	0	$30,000
14.3 Initiate increased auditing of non-EPA licensed industrial and commercial premises by Council officers. As a priority, investigate industrial area upstream of the high metal concentrations within Cup and Saucer Creek near Kingsgrove Road.	124*	0	0	0	0	0	0	$67,000	$67,000
MANAGERIAL									
19.1 Identify and map ownership of all government land within the Cooks River Catchment and agree responsibilities between land managers in the catchment.	3	$5,000	$1,000	0	$1,000	0	$1,000	0	$1,000
19.2 Define and agree notes and responsibilities for stormwater and catchment management within Cooks River based on Action No. 90.	17	$5,000	0	0	0	0	0	0	0

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4 +	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
17.1 Investigate and develop opportunities for community, schools and businesses which are part of the problem to become part of the solution by becoming involved in stormwater management. For example, through on ground works, green industry awards, bush regeneration/tree planting, community bird watching programs, school problem solving, curriculum.	50*	0	0	0	0	$26,000	0	0	$13,000
17.2 Implement greater use of ethnic media to reach non-English speaking community. Develop information sheets and disseminate through community centres and schools.	51*	0	0	0	0	0	0	$10,000	$5,000
20.1 Integrate Council's knowledge and information through catchment wide water quality monitoring and reporting. Evaluate data to determine strategic responses to problems identified by the monitoring program.	89	$50,000	0	$50,000	0	$50,000	0	$50,000	0
SUSPENDED SOLIDS									
21.1 Educate occupiers of commercial premises and residences about not hosing down footpath areas.	83*	0	0	$30,000	0	0	$15,000	0	$15,000
22.2 Educate construction contractors on appropriate sediment controls based on best practice guidelines (eg. signs on sediment fences).	90*	0	0	0	0	0	$13,000	0	$13,000
HABITAT LOSS AND RIVER HEALTH									
25.2 Develop a catchment policy for landscaping along foreshore and waterways using native species, based on existing reports and incorporate into Council planning controls.	27*	$8,000	0	0	0	0	0	0	0
TOTAL		$94,000	$7,000	$97,000	$7,000	$192,000	$91,000	$129,000	$183,500

* These Actions for a component of the recent Stormwater Trust Grant ($1.3 million) and may be partly funded by this program.

Table 9.1b: Stormwater Management Implementation Strategy – Association of Councils (Level 2 Actions)

Action	Rank	Financial Year and Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
NUTRIENTS AND BACTERIA				
9.2 Investigate the feasibility of introducing dung beetles to decompose dog droppings in council Park areas based on outcomes of Strathfield council trial.	45	$1,500	$15,000	0
TOTAL		$1,500	$15,500	$2,500

Table 9.2a: Stormwater Management Implementation Program – Canterbury Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
5.1 Trial management options for litter in parks along the Cooks River foreshore by removing bins and providing signage "Thank You for caring for the park and the Cooks River". In some areas providing additional bin facilities is another. Monitor success of the trial bin project and implement appropriate strategy for ALL parks along the Cooks River foreshore.	28	$8,000	0	0	0	0	0	0	0
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$3,120	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$3,120	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$1,920	0	0	$2,400	0	$2,400
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$1,870	$2,400	0	$2,400	0	$2,400
6.1 Maintain the existing pollutec pollutant trap at the park near Belmore Rugby League field.	62	0	$10,000	0	$10,000	0	$10,000	0	$10,000
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$6,240	0	0	$3,120
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$480	$6,240
7.10 Install and maintain proposed GPT at Tasker Park, Campsie.	128	0	0	0	0	0	0	$150,000	$15,000
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$360,000	0	$360,000	0	$360,000	0	$360,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$2,400	$36,000
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$1,870	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$480	$480	0	$480	0	$480	0	$480
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$6,240	$3,120	0	$3,120	0	$3,120
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$6,900	0	0	$1,700
13.8 Install backwash storage tanks and dispose of backwash from Roselands and Canterbury Pools to sewer.	106	$60,000	$5,000	0	0	0	0	0	0
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$6,240	0	0	$3,120	0	$3,120
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$4,800	$2,880	0	$2,880	0	$2,880	0	$2,880

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$24,000	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$4,800	0	0	$2,400	0	$2,400
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$6,000	0	0	$6,000
14.3 Initiate increased auditing of non-EPA licensed industrial and commercial premises by Council officers. As a priority, investigate industrial area upstream of the high metal concentrations within Cup and Saucer Creek near Kingsgrove Road.	124	0	0	0	0	0	0	0	$16,200
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$6,240	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$3,120	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$7,200	0	0	0	0	0
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$3,120	0	0	$3,120	0	$3,120
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$3,120	0	0	0	0	0	0	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	$50,000	0
24.3 Refill eroded ground behind embankment along Cooks River downstream of Fore St, Earlwood.	41	$25,000	0	0	0	0	0	0	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$9,600	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$12,480	0	$12,480	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$24,000	0	$24,000	0	$24,000	0	$24,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	$24,000	0	$24,000	0	$24,000
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$6,000	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$3,120	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$2,400	0	0	0	0	0	0	0

Table 9.2a: Stormwater Management Implementation Strategy – Canterbury Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$3,120	0	0	0	0	0
28.4 Prepare a Mangrove Management Plan to identify areas for regeneration either via natural colonisation or habitat generation and areas where mangroves are removed to prevent flooding. Comply with NSW State Rivers and Estuaries Policy.	35	0	0	0	0	$10,000	0	0	0
28.5 Negotiate with DLWC to replace sheet piling along Cooks River, between the Undercliff Bridge and the footbridge at Flinders Road with more natural bank stabilisation where possible.	49	0	0	0	0	0	0	$2,000	0
27.1 Incorporate Wolli Creek Mangroves and Saltmarsh through planning policies and bushcare regeneration programs. Investigate measures to minimise sedimentation and disturbance from railways.	67	0	0	0	0	0	0	$1,600	0
27.2 Protect the Third Ave Remnant bushland in Campsie, through incorporation in planning policies.	68	0	0	0	0	0	0	$1,600	0
27.5 Undertake bush regeneration and protection works on remnant vegetation along Wolli Creek from Bexley Road, eastwards.	72	0	0	0	0	0	0	$5,000	$5,000
TOTAL		$124,150	$402,360	$50,350	$426,880	$65,620	$437,920	$225,560	$527,180

Table 9.2b: Stormwater Management Implementation Program – Canterbury Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
7.4 Provide buffer strips behind embankment walls of channel at Rudd Park, Belfield where necessary.	96	$1,500	$15,000	$5,000
7.15 Retrofit litter baskets/silt traps at selected pits in Orissa St subcatchment, Campsie.	135	$1,000	$10,000	$1,000
7.20 Provide gross pollutant interceptors at pipe outlets (approx. 3) to Cup and Saucer Creek at industrial area near Alfred St, Campsie.	143	$2,500	$25,000	$7,000
7.13 Provide pit litter baskets at selected locations in Campsie industrial area within Cup and Saucer Creek catchment.	145	$1,000	$10,000	$10,000
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$5,000	$156,000	$40,500
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$5,000	$144,000	$144,000
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$4000	0	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$480	$4,800	0
13.4 Construct small wetland above the tidal limit at Heynes Reserve, Canterbury to receive flows from Cup and Saucer canal.	101	$5,000	$75,000	$7,500
13.7 Construct offline wetland upstream of tidal limit on Omaha Canal.	104	$5,000	$100,000	$10,000
NUTRIENTS AND BACTERIA				
16.1 Investigate need for site remediation and leachate control at the former brick pit at Harp St, Campsie.	12	$2,500	$25,000	0
SUSPENDED SOLIDS				
24.12 Provide bank stabilisation along the Cooks River between Illawarra Rd to Marsh St, Arncliffe.	107	$5,000	$100,000	$25,000
24.13 Provide bank stabilisation, in association with revegetation works, along the Cooks River between Church St to Ford Ave, Hurlstone Park.	112	$5,000	$100,000	$2,500
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$5,000	$48,000	$2,400
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$1,000	$2,400	0
28.8 Negotiate with DLWC to selectivley replace steel sheet piling along Cooks River banks between Church Street, Canterbury and Flinders Road, using rock embankment/natural vegetation, following a feasibility study.	121	$5,000	$62,500	$2,500
TOTAL		$53,980	$937,700	$256,900

Table 9.3a: Stormwater Management Implementation Program – Rockdale Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
5.1 Trial management options for litter in parks along the Cooks River foreshore by removing bins and providing signage "Thank You for caring for the park and the Cooks River". In some areas providing additional bin facilities is another. Monitor success of the trial bin project and implement appropriate strategy for ALL parks along the Cooks River foreshore.	28	$8,000	0	0	0	0	0	0	0
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$2,600	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$2,600	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$1,600	0	0	$2,000	0	$2,000
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$1,560	$1,300	0	$1,300	0	$1,300
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$5,200	0	0	$2,500
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$400	$5,200
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$300,000	0	$300,000	0	$300,000	0	$300,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$2,000	$30,000
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$1,560	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	0	$400	0	$400	0	$400	0	$400
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$5,200	$2,600	0	$2,600	0	$2,600
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$6,000	0	0	$1,500
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$5,200	$2,600	0	$2,600	0	$2,600

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4 +	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$4,000	$2,400	0	$2,400	0	$2,400	0	$2,400
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	$20,000	0	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$4,000	0	0	$2,000	0	$2,000
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$5,000	0	0	$5,000
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks (where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$5,200	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$2,600	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$6,000	0	0	$4,000	0	$4,000
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$2,600	0	0	$2,600	0	$2,600
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$2,600	0	0	0	0	0	0	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	$50,000	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$8,000	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$10,400	0	$10,400	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$20,000	0	$20,000	0	$20,000	0	$20,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	$20,000	0	$20,000	0	$20,000

Table 9.3a: Stormwater Management Implementation Strategy – Rockdale Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4 +	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$5,000	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$2,600	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$2,000	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$2,600	0	0	0	0	0
28.4 Prepare a Mangrove Management Plan to identify areas for regeneration either via natural colonisation or habitat generation and areas where mangroves are removed to prevent flooding. Comply with NSW State Rivers and Estuaries Policy.	35	0	0	0	0	0	0	0	0
27.1 Incorporate Wolli Creek Mangroves and Saltmarsh through planning policies and bushcare regeneration programs. Investigate measures to minimise sedimentation and disturbance from railways.	67	0	0	0	0	0	0	$1,600	0
27.5 Undertake bush regeneration and protection works on remnant vegetation along Wolli Creek from Bexley Road, eastwards.	72	0	0	0	0	0	0	$5,000	$5,000
TOTAL		$322,800	$41,960	$41,960	$369,300	$359,900	$359,900	$69,400	$409,100

Table 9.3b: Stormwater Management Implementation Program – Rockdale Council (Level 2 Actions)

Action	Rank	Financial Year and Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
7.3 Provide minor gross pollutant traps on pipe outlets to Bardwell Creek near Bardwell Rd.	87	$5,000	$120,000	$50,000
7.7 Provide coarse trash rack along Bardwell Creek near Ellerslie Rd, Bexley North to protect the downstream bushland.	105	$3,000	$30,000	$100,000
7.18 Provide pit litter baskets at selected locations within Bardwell Creek catchment.	140	$5,000	$100,000	$100,000
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$5,000	$130,000	$30,000
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$5,000	$120,000	$120,000
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$4,000	0	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$1,000	0	$4,000
13.3 Construct wetland along Bardwell Creek downstream of Ellierslie Road and rehabilitate riparian zone where possible through Shepard Reserve and Favell Picnic Area.	95	$5,000	$250,000	$25,000
13.6 Construct offline wetlands or pond system adjacent to Muddy Creek in White Oak Reserve.	103	$5,000	$125,000	$12,500
13.10 Investigate opportunity to develop additional wetland as part of the proposed NPWS regional park in lower Wolli Creek area.	123	$5,000	$500,000	$20,000
SUSPENDED SOLIDS				
24.5 Provide buffer strips along drainage line to Bardwell Creek through Jubilee Park and Bardwell Park.	64	$3,000	$30,000	$5,000
24.9 Investigate appropriate bank remediation works along Bardwell Creek in conjunction with revegetation upstream of Bardwell Rd, Bardwell Park.	94	$5,000	$100,000	$5,000
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$4,000	$40,000	$2,000
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	0	$2,000	0
TOTAL		$55,000	$473,500	$473,500

Table 9.4a: Stormwater Management Implementation Program – Marrickville Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
5.1 Trial management options for litter in parks along the Cooks River foreshore by removing bins and providing signage "Thank You for caring for the park and the Cooks River". In some areas providing additional bin facilities is another. Monitor success of the trial bin project and implement appropriate strategy for ALL parks along the Cooks River foreshore.	28	$8,000	0	0	0	0	0	0	0
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$1,560	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$1,560	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$960	0	0	$1,200	0	$1,200
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$930	0	0	$780	0	$780
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$3,120	0	0	$1,560
7.8 Install proposed pollutant trap at Tennyson St, Dulwich Hill subcatchment outlet.	110	0	0	0	0	0	0	$150,000	$15,000
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$240	$3,120
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$180,000	0	$180,000	0	$180,000	0	$180,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$1,200	$18,000
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$930	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	0	$240	0	$240	0	$240	0	$240
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$3,120	$1,560	0	$1,560	0	$1,560
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$3,600	0	0	$900
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$3,120	0	0	$1,560	0	$1,560

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$2,400	$1,440	0	$1,440	0	$1,440	0	$1,440
16.2 Remediate Tempe Reserve landfill area to prevent off site leachate of contaminants.	63	0	0	0	0	0	0	$100,000	$10,000
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$12,000	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$2,400	0	0	$1,200	0	$1,200
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$3000	0	0	$3,000
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$3,120	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$1,560	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$3,600	0	0	$2,400	0	$2,400
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$1,560	0	0	$1,560	0	$1,560
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$1,560	0	0	0	0	0	0	0
24.4 Investigate cause of sludge buildup at Mackay Park, Marrickville.	47	0	0	0	0	0	0	0	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$4,800	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$6,200	0	$6,200	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$12,000	0	$12,000	0	$12,000	0	$12,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	$12,000	0	$12,000	0	$12,000
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$3,000	0	0	0	0	0	0	0

Table 9.4b: Stormwater Management Implementation Strategy – Marrickville Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$1,560	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$1,200	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$1,560	0	0	0	0	0
28.4 Prepare a Mangrove Management Plan to identify areas for regeneration either via natural colonisation or habitat generation and areas where mangroves are removed to prevent flooding. Comply with NSW State Rivers and Estuaries Policy.	35	0	0	0	0	$10,000	0	0	0
28.5 Negotiate with DLWC to replace sheet piling along Cooks River, between the Undercliff Bridge and the footbridge at Flinders Road with more natural bank stabilisation where possible.	49	0	0	0	0	0	0	$2,000	0
27.3 Protection of remnant vegetation within Marrickville Foreshore Reserves.	69	0	0	0	0	$5,000	0	0	$5,000
TOTAL		$23,330	$193,680	$25,170	$207,240	$215,940	$215,940	$259,640	$272,520

Table 9.4b: Stormwater Management Implementation Program – Marrickville Council (Level 2 Actions)

Action	Rank	Financial Year and Expenditure		
		Year One Investiment Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
7.2 Investigate feasibility of installing a gross pollutant interceptor on pipe outlet near Thornley St, Marrickville.	86	$5,000	$70,000	$5,000
7.5 Retrofit pit litter baskets at selected sites Hercules St area, Dulwich Hill.	97	$1,000	$10,000	$5,000
7.21 Install gross pollutant traps before pipe outlets (approx. 2) to Cooks River at HJ Mahoney Memorial Reserve, Marrickville South.	139	$5,000	$100,000	$30,000
7.22 Install gross pollutant traps before pipe outlets (approx. 3) to Cooks River at Steel Park, Marrickville South.	140	0	0	0
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$5,000	$78,000	$18,000
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$5,000	$72,000	$7,200
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$4000	0	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$240	$2,400	0
8.5 Provide public car wash areas in existing high density residential areas which drain and are connected to sewer or a suitable alternative. Also provide signs to educate people about carwashing in the streets.	119	$2,000	$20,000	$10,000
SUSPENDED SOLIDS				
24.8 Develop erosion & sediment control plan for Cooks River Goods Yards, Sydenham.	93	$3,000	$30,000	$10,000
24.12 Provide bank stabilisation along the Cooks River between Illawarra Rd to Marsh St, Arncliffe.	107	$5,000	$100,000	$2,500
24.13 Provide bank stabilisation, in association with revegetation works, along the Cooks River between Church St to Ford Ave, Hurlstone Park.	112	$5,000	$100,000	$2,500
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$2,400	$24,000	$1,200
24.16 Install drainage pumping station /detention pit and silt screen at Mary Street, St Peters.	149	$5,000	$150,000	$15,000
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$120	$1,200	0
28.8 Negotiate with DLWC to selectivley replace steel sheet piling along Cooks River banks between Church Street, Canterbury and Flinders Road, using rock embankment/natural vegetation, following a feasibility study.	121	$5,000	$62,500	$2,500
TOTAL		$52,760	$820,100	$108,900

Table 9.5a: Stormwater Management Implementation Program – South Sydney (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$3,120	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$3,120	0	0	0	0	0	0	00
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$800	0	0	$1,000	0	$1,000
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$1,870	$2,400	0	$2,400	0	$2,400
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$2,600	0	0	$1,300
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$480	$6,240
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$150,000	0	$150,000	0	$150,000	0	$150,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$1,000	$15,000
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$780	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$200	$200	0	$200	0	$200	0	$200
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$2,600	$1,300	0	$1,300	0	$1,300
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$3,000	0	0	$750
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$2,600	0	0	$1,300	0	$1,300
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$4,800	$2,880	0	$2,880	0	$2,880	0	$2,880
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$10,000	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$2,000	0	0	$1,000	0	$1,000
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$2,500	0	0	$2,500

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
MANGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$2,600	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$1,300	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$3,000	0	0	$2,000	0	$2,000
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$1,300	0	0	$1,300	0	$1,300
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$1,300	0	0	0	0	0	0	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$41,000	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$5,200	0	$5,200	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$10,000	0	$10,000	0	$10,000	0	$10,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	$10,000	0	$10,000	0	$10,000
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$2,500	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$1,300	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$1,000	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$1,300	0	0	0	0	0
TOTAL		$19,420	$163,080	$59,070	$176,780	$23,300	$183,380	$6,680	$209,170

Table 9.5a: Stormwater Management Implementation Strategy – South Sydney Council (Level 1 Actions)

Table 9.5b Stormwater Management Implementation Program – South Sydney Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$5,000	$65,000	$15,000
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$5,000	$60,000	$6,000
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$2,500	0	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$200	$2,000	0
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$2,000	$20,000	$1,000
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$200	$1,000	0
TOTAL		$14,900	$22,000	$22,000

Table 9.6a: Stormwater Management Implementation Program – Hurstville Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$1,200	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$1,200	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$720	0	0	$900	0	$900
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$700	$600	0	$600	0	$600
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$2,350	0	0	$1,200
7.1 Require the incorporation of litter & erosion controls into redevelopment of the site upstream of King Georges Rd, Hurstville.	85	$3,000	0	0	0	0	0	0	0
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$200	$2,340
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$297,000	0	$297,000	0	$297,000	0	$297,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$900	$13,500
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$700	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$1,300	$1,500	0	$1,500	0	$1,500	0	$1,500
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	0	$2,340	0	$1,200	0	$1,200
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$2,700	0	0	$680
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$2,340	0	0	$1,200	0	$1,200
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$1,800	$100	0	$100	0	$100	0	$100
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$9,000	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$1,800	0	0	$900	0	$900
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$2,250	0	0	2,250

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$2,340	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$1,200	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$2,700	0	0	$1,800	0	$1,800
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$1,200	0	0	$1,200	0	$1,200
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$1,200	0	0	0	0	0	$4,500	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	0	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$3,600	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$4,700	0	$4,700	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$9,000	0	$9,000	0	$9,000	0	$9,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	$40,000	0	$40,000	0	$40,000	0	$40,000
HABITAT LOSS AND RIVER HEALTH									
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$1,200	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$1,200	0	0	0	0	0
TOTAL		$12,740	$347,600	$16,660	$350,540	$21,000	$355,400	$10,300	$375,370

Table 9.6b: Stormwater Management Implementation Program – Hurstville Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$1,000	$5,850	$13,500
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$5,000	$54,000	$5,400
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$200	$2,250	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$200	$1,800	0
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$1,800	$18,000	$900
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$200	$900	0
TOTAL		$8,400	$19,800	$19,801

Table 9.7a: Stormwater Management Implementation Program – Bankstown Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$1,200	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$1,200	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$720	0	0	$900	0	$900
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$700	$600	0	$600	0	$600
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$2,350	0	0	$1,200
6.2 Maintain existing trash rack at Muir Rd, Chullora.	108	0	$20,000	0	$20,000	0	$20,000	0	$20,000
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$200	$2,340
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$135,000	0	$135,000	0	$135,000	0	$135,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$900	$13,500
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$700	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$180	$180	0	$180	0	$180	0	$180
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	0	$2,340	0	$1,200	0	$1,200
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$2,700	0	0	$680
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$2,340	0	0	$1,200	0	$1,200
TOXICANTS									
14.6 Install oil separator upstream of Freshwater Creek to catch oils from motor wreckers entering the waterway.	new	$80,000	$5,000	0	$5,000	0	$5,000	0	$5,000
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$1,800	$100	0	$100	0	$100	0	$100
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$9,000	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$1,800	0	0	$900	0	$900

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$2,250	0	0	2,250
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$2,340	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$1,200	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$2,700	0	0	$1,800	0	$1,800
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$1,200	0	0	$1,200	0	$1,200
SUSPENDED SOLIDS									
24.1 Investigate and install erosion controls for development immediately upstream of drainage channel at eastern boundary of Rookwood Cemetery and for the channel itself.	33	$2,000	0	0	0	0	0	0	0
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$1,200	0	0	0	0	0	$4,500	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	0	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$3,600	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$4,700	0	$4,700	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$9,000	0	$9,000	0	$9,000	0	$9,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	$9,000	0	$9,000	0	$9,000	0	$9,000
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$2,250	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$1,200	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$900	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$1,200	0	0	0	0	0
26.2 Protect Freshwater Creek during redevelopment of the Chullora Site through appropriate planning controls and design. Continue to liaise with Bankstown Bushland Society in this process.	66	$5,000	0	0	0	0	0	0	0
TOTAL		$98,770	$178,280	$16,660	$181,220	$21,000	$186,080	$10,300	$206,050

Table 9.7a: Stormwater Management Implementation Strategy – Bankstown Council (Level 1 Actions)

Table 9.7b: Stormwater Management Implementation Program – Bankstown Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
7.17 Provide GPT/wetland downstream of Hume Highway along Greenacre Park SWS.	137	$1,000	$5,850	$13,500
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$5,000	$58,500	13,500
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$5,000	$54,000	$5,400
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$200	$2,250	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$200	$1,800	0
8.5 Provide public car wash areas in existing high density residential areas which drain and are connected to sewer or a suitable alternative. Also provide signs to educate people about carwashing in the streets.	119	$2,000	$20,000	$10,000
SUSPENDED SOLIDS				
24.15 Install detention basin at Chullora Railway Workshops.	133	$5,000	$100,000	$20,000
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$1,800	$18,000	$900
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$200	$900	0
TOTAL		$20,400	$63,300	$63,300

Table 9.8a: Stormwater Management Implementation Program – Strathfield Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$900	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$900	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	$8,000	0	0	0	0	0	0	0
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$560	0	0	$700	0	$700
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$1,800	0	0	$900
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$150	$1,800
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$105,000	0	$105,000	0	$105,000	0	$105,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$750	$10,500
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$550	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$140	$140	0	$140	0	$140	0	$140
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$1,800	$900	0	$900	0	$900
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$2,100	0	0	$525
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$1,800	0	0	$900	0	$900
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$1,400	$90	0	$90	0	$90	0	$90
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$7,000	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$1,400	0	0	$700	0	$700
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$1,750	$1,750	0	$1,750

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$1,800	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$900	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$2,100	0	0	$1,400	0	$1,400
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$900	0	0	$900	0	$900
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$900	0	0	0	0	0	0	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$2,800	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$3,600	0	$3,600	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$7,000	0	$7,000	0	$7,000	0	$7,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	$7,000	0	$7,000	0	$7,000
HABITAT LOSS AND RIVER HEALTH									
28.12 Construct proposed wetland in Cox's Creek upstream of Drone Street.	-	$72,000	0	0	$3,000	0	$3,000	0	$3,000
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$1,750	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$900	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$700	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$900	0	0	0	0	0
TOTAL		$89,040	$112,230	$14,060	$123,130	$16,250	$129,480	$4,500	$143,205

Table 9.8b: Stormwater Management Implementation Program – Strathfield Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
7.14 Investigate provision of Litter baskets at Cosgrove Road/ Madeline St industrial area.	134	$1,500	$15,000	$10,000
7.16 Investigate provision of offline GPT or wet pond system on vacant land at bend in Cooks River adjacent to Dean Reserve, Strathfield.	136	$5,000	$125,000	$10,000
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$4,500	$45,000	$10,500
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$5,000	$42,000	$4,200
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$1,750	0	$10,000
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$200	$1,400	$10,000
13.2 Investigate provision of constructing an urban stream at Strathfield Golf Course/Freshwater Park.	91	$5,000	$200,000	$10,000
13.5 Investigate feasibility of installing a constructed wetland in Cooke Park downstream of Madeline Street, or upstream of Madeline Street in Begnell Park.	102	$5,000	$125,000	$12,500
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$1,400	$14,000	$700
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$200	$700	0
28.3 Investigate naturalising concrete channel by placing rock and planting native vegetation at Chain of Ponds reserve area, where space allows.	48	$5,000	$100,000	$2,000
28.6 Investigate river bank stabilisation works and create a more natural bank and riparian zone at Freshwater Park.	56	$5,000	$100,000	2,500
TOTAL		$39,550	$768,100	$82,400

Table 9.9a: Stormwater Management Implementation Program – Botany Bay Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$650	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$650	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$400	0	0	$500	0	$500
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$390	$320	0	$320	0	$320
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$1,300	0	0	$650
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$100	$1,300
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$750,000	0	$750,000	0	$750,000	0	$750,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$500	$7,500
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$390	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$100	$100	0	$100	0	$100	0	$100
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$1,300	$650	0	$650	0	$650
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$1,500	0	0	$375
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$1,300	$650	0	$650	0	$650
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$1,000	$60	0	$60	0	$60	0	$60
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$5,000	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$1,000	0	0	$500	0	$500
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$1,250	$1,250	0	$1,250

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$1,300	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$650	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$1,500	0	0	$1,000	0	$1,000
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$650	0	0	$650	0	$650
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$650	0	0	0	0	0	0	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	$2,500	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$2,000	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$2,600	0	$2,600	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$5,000	0	$5,000	0	$5,000	0	$5,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	$5,000	0	$5,000	0	$5,000
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$1,250	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$650	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$500	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$650	0	0	0	0	0
28.4 Prepare a Mangrove Management Plan to identify areas for regeneration either via natural colonisation or habitat generation and areas where mangroves are removed to prevent flooding. Comply with NSW State Rivers and Estuaries Policy.	35	0	0	0	0	$10,000	0	0	0
TOTAL		$6,490	$755,160	$10,490	$761,780	$21,650	$765,680	$5,700	$775,505

Table 9.9a: Stormwater Management Implementation Strategy – Botany Bay Council (Level 1 Actions)

Table 9.9b: Stormwater Management Implementation Program – Botany Bay Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$3,000	32,500	$7,500
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$3,000	$30,000	$3,000
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$1,250	0	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$200	$1,000	0
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$1,000	$10,000	$500
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$200	$500	0
TOTAL		$8,650	$11,000	$11,000

Table 9.10a: Stormwater Management Implementation Program – Burwood Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$260	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$260	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$160	0	0	$200	0	$200
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$150	$130	0	$130	0	$130
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$520	0	0	$260
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$40	$520
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$30,000	0	$30,000	0	$30,000	0	$30,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$200	$3,000
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$150	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$40	$40	0	$40	0	$40	0	$40
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$520	$260	0	$260	0	$260
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$600	0	0	$150
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$520	$260	0	$260	$260	0
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$400	$25	0	$25	0	$25	0	$25
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$2,000	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$400	0	0	$200	0	$200
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$500	$500	0	$500

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$520	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$260	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$600	0	0	$400	0	$400
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$4,260	0	0	$260	0	$260
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$260	0	0	0	0	0	0	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	$1,000	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$800	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$1,040	0	$1,040	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$2,000	0	$2,000	0	$2,000	0	$2,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	$2,000	0	$2,000	0	$2,000
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$500	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$260	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$200	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$260	0	0	0	0	0
TOTAL		$2,590	$32,065	$8,190	$34,715	$4,660	$36,275	$2,540	$39,945

Table 9.10a: Stormwater Management Implementation Strategy – Burwood Council (Level 1 Actions)

Table 9.10b: Stormwater Management Implementation Program – Burwood Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$1,300	$13,000	$3,000
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$1,200	$12,000	$1,200
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$420	0	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	0	$400	0
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$400	$4,000	$200
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	0	$400	0
TOTAL		$3,320	$4,400	$4,400

Table 9.11a: Stormwater Management Implementation Program – Auburn Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$130	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$130	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$80	0	0	$100	0	$100
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$75	$60	0	$60	0	$60
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$260	0	0	$130
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$20	$260
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$15,000	0	$15,000	0	$15,000	0	$15,000
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$100	$1,500
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$80	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$20	$20	0	$20	0	$20	0	$20
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$260	$130	0	$130	0	$130
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$300	0	0	$75
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$260	$130	0	$130	0	$130
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$200	$20	0	$20	0	$20	0	$20
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$1,000	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$200	0	0	100	0	100
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$25	$25	0	$25

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$260	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$130	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$300	0	0	$200	0	$200
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$130	0	0	$130	0	$130
SUSPENDED SOLIDS									
24.1 Investigate and install erosion controls for development immediately upstream of drainage channel at eastern boundary of Rookwood Cemetery and for the channel itself.	33	$2,000	0	0	0	0	0	0	0
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$130	0	0	0	0	0	0	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	$500	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$800	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$520	0	$520	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$1,000	0	$1,000	0	$1,000	0	$1,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	0	0	$1,000	0	$1,000
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$130	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$130	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$100	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$130	0	0	0	0	0
TOTAL		$3,180	$16,040	$2,495	$16,360	$2,105	$17,915	$1,140	$19,880

Table 9.11a: Stormwater Management Implementation Strategy – Auburn Council (Level 1 Actions)

Table 9.11b: Stormwater Management Implementation Program – Aurburn Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Onvestigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$650	$6,500	$1,500
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$600	$6,000	$600
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$250	0	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$200	$200	0
SUSPENDED SOLIDS				
24.14 Provide stream remediation/bank stabilisation along Cooks River downstream of Chullora Rail Workshops to Strathfield Golf Course.	117	$5,000	$750,000	$5,000
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$200	$2,000	$100
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$200	$100	0
TOTAL		$7,100	$7,200	$7,200

Table 9.12a: Stormwater Management Implementation Program – Randwick Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$130	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$130	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$80	0	0	$100	0	$100
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$260	0	0	$130
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$20	$260
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	0	0	0	0	0	0	0
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$100	$1,500
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$80	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$20	$20	0	$20	0	$20	0	$20
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$260	$130	0	$130	0	$130
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$300	0	0	$75
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$260	$130	0	$130	0	$130
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$200	$20	0	$20	0	$20	0	$20
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$500	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$200	0	0	100	0	100
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$25	$25	0	$25
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$260	0	0	0	0	0	0	0

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$130	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$150	0	0	$100	0	$100
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$130	0	0	$130	0	$130
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$130	0	0	0	0	0	0	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	$500	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$800	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$520	0	$520	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$1,000	0	$1,000	0	$1,000	0	$1,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	0	0	0	0	$1,000
HABITAT LOSS AND RIVER HEALTH									
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$130	0	0	0	0	0
TOTAL		$ 950	$1,040	$2,140	$1,300	$1,605	$1,755	$1,140	$4,720

Table 9.12b: Stormwater Management Implementation Program – Randwick Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
7.6 Install pit litter baskets in area near the Australian Golf Club where appropriate.	98	$1,000	$10,000	$5,000
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$650	$6,500	$1,500
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$300	$3,000	$300
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$250	0	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$200	$200	0
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$100	$1,000	$100
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$200	$100	0
TOTAL		$2.700	$20,800	$6,900

Table 9.13a: Stormwater Management Implementation Program – Kogarah Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$65	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$65	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$40	0	0	$50	0	$50
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$70	$30	0	$30	0	$30
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$130	0	0	$65
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$10	$130
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$7,500	0	$7,500	0	$7,500	0	$7,500
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$50	$7,50
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$40	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$20	$20	0	$20	0	$20	0	$20
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$130	$65	0	$65	0	$65
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$150	0	0	$40
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$130	$65	0	$65	0	$65
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$100	$20	0	$20	0	$20	0	$20
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$500	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$100	0	0	$50	0	$50
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$25	$25	0	$25

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$130	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$65	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$150	0	0	$100	0	$100
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$65	0	0	$65	0	$65
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$65	0	0	0	0	0	0	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	$250	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$800	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$260	0	$260	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$500	0	$500	0	$500	0	$500
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	$500	0	$500	0	$500
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$65	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$65	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$50	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$65	0	0	0	0	0
0		$ 600	$8,040	$1,680	$8,700	$1,065	$8,990	$ 570	$9,282

Table 9.13b: Stormwater Management Implementation Program – Kogarah Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$300	$3,250	$750
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$300	$3,000	$300
NUTRIENTS AND BACTERIA				
13.1 Investigate water management practices on all Golf Courses and identify opportunities to install wetlands or options for waste refuse.	34	$200	0	0
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$200	$100	0
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$100	$1,000	$100
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$200	$100	0
TOTAL		$1,300	$1,150	$1,150

Table 9.14a: Stormwater Management Implementation Program – Ashfield Council (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$65	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$65	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$40	0	0	$50	0	$50
5.2 Target regular users of parks adjacent to river eg. sporting clubs. Encourage these clubs to be responsible for leaving the area free of Litter after use of the facilities through leasing or hire arrangements to implement a cleanup charge for areas left in an unsatisfactory state.	61	0	0	$70	$30	0	$30	0	$30
3.2 Upgrade recycling bins which perform poorly in conjunction with the Inner Sydney Waste Board, by identifying alternate bins or educating users to prevent litter escaping.	79	0	0	0	0	$130	0	0	$65
2.2 Warn and fine people littering in accordance with EPA authority for action to be taken by authorised Council officers. Implement a recording system for fines issued.	115	0	0	0	0	0	0	$10	$130
4.3 Revise existing dry street sweeping programs based on cost-benefits and continue in commercial, industrial and residential areas, including carparks.	154	0	$7,500	0	$7,500	0	$7,500	0	$7,500
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$50	$7,50
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$40	0	0	0	0	0	0	0
9.1 Provide 'doggie dunnit' bags/stations at designated dog exercise parks.	22	$20	$20	0	$20	0	$20	0	$20
10.1 Review procedures of council maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$130	$65	0	$65	0	$65
10.2 Educate the community not to sweep or blow leaves into the gutter by providing alternative disposal options (mulch and compost) and supporting the Cooks River Valley Association's "Garbage and Gutters" initiative.	59	0	0	0	0	$150	0	0	$40
8.4 Incorporate in council planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$130	$65	0	$65	0	$65
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$100	$20	0	$20	0	$20	0	$20
15.2 Review weed management strategies in Council Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	$500	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$100	0	0	$50	0	$50
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$25	$25	0	$25

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
MANAGERIAL									
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$130	0	0	0	0	0	0	0
18.2 Incorporate into DCP's additional controls for owner/developers who build or pave over more than 50% of land area. Investigate opportunity to provide incentives/rebates for those who install additional stormwater controls.	9	0	0	$65	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	$800	0	0	$100	0	$100
20.2 Undertake mapping of stormwater infrastructure in all Council areas using existing GIS base map.	52	0	0	$65	0	0	$65	0	$65
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$65	0	0	0	0	0	0	0
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	$250	0
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	$600	0	0	0	0	0
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	0	0	$260	0	$260	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$500	0	$500	0	$500	0	$500
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	0	0	$500	0	$00	0	$500
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$65	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	0	0	$65	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within Council planning policies and development controls.	8	$50	0	0	0	0	0	0	0
25.4 Provide native vegetation maps and lists to nurseries, landscapers and residents to promote greater use of native vegetation in landscaping works.	24	0	0	$65	0	0	0	0	0
TOTAL		$ 600	$8,040	$2,130	$8,700	$1,065	$8,490	$ 570	$9,282

Table 9.14a: Stormwater Management Implementation Strategy – Ashfield Council (Level 1 Actions)

Table 9.14b: Stormwater Management Implementation Program – Ashfield Council (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$300	$3,250	$750
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	$300	$3,000	$300
NUTRIENTS AND BACTERIA				
11.1 Investigate opportunities to replace fertiliser used on playing fields with worms (based on outcomes of ongoing trial into effectiveness by Marrickville Council) or reuse captured stormwater which may be high in nutrients for ground irrigation.	46	$200	$100	0
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	$100	$1,000	$100
HABITAT LOSS AND RIVER HEALTH				
25.3 Investigate incorporation of propagation programs for native riparian vegetation in Council nurseries.	10	$200	$100	0
TOTAL		$1,101	$1,150	$1,150

Table 9.15a: Stormwater Management Implementation Program – Sydney Water (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
7.9 Maintain GPT and construct wetland in redevelopment of SRA land at Chullora Rail Workshops and provide maintenance.	118	0	$25,000	0	0	0	0	$250,000	0
6.3 Investigate improvements to litter boom along Cooks River at Fifth Avenue Campsie with Cooks River Valley Association to improve the performance of the boom.	109	0	0	0	0	$10,000	0	0	$10,000
6.4 Maintain existing GPT at Orissa Drain, Fifth Avenue Campsie.	125	0	$34,300	0	$34,300	0	$34,300	0	$34,300
6.5 Maintain existing GPT and drainage pumping station/detention basin at the Brickpit, Railway Road, Sydenham.	127	0	$90,000	0	$90,000	0	$90,000	0	$15,000
6.6 Maintain existing trash rack at Mackey Park, Marrickville.	141	0	$20,000	0	$20,000	0	$20,000	0	$20,000
6.7 Maintain existing trash rack at Cup & Saucer Creek, Canterbury.	150	0	$20,000	0	$20,000	0	$20,000	0	$20,000
6.8 Maintain existing GPT at Wolli Creek, Kingsgrove.	151	0	$90,000	0	$90,000	0	$90,000	0	$90,000
NUTRIENTS AND BACTERIA									
8.6 Investigate options to implement requirement for inspection of sewer and stormwater connections into certification required for all residential and commercial property sales.	25	0	0	$13,000	0	0	0	0	0
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	0	0	$30,000	$1,800	0	$1,800	0	$1,800
MANAGERIAL									
19.1 Identify and map ownership of all government land within the Cooks River Catchment and agree responsibilities between land managers in the catchment.	3	$5,000	0	0	$1,000	0	$1,000	0	$1,000
19.2 Define and agree responsibilities for stormwater and catchment management within Cooks River based on Action No. 90.	17	$5,000	0	0	0	0	0	0	0
18.3 State agencies to ensure stormwater management policies for developments (such as the M5 Motorway, Rail Yard redeveopment and Airport expansions etc.) are consistent with Council planning policies and controls for stormwater management.	18	$1,000	0	0	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	0	0	0	0	0	0
SUSPENDED SOLIDS									
24.2 Investigate continued dredging of sediments in most severely silted up reaches of the River,. (eg. Third Ave, Campsie) upstream of Footbridge linking Barool Avenue and Church Street, Canterbury and identify actions in accordance with the requirements of the NSW State Rivers and Estuaries Policy.	40	0	0	0	0	0	0	$50,000	0
23.4 Maintain existing detention pit/drainage pumping station at Carrington Road, Marrickville.	120	0	$20,600	0	$20,600	0	$20,600	0	$20,600
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$24,000	0	$24,000	0	$24,000	0	$24,000

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
HABITAT LOSS AND RIVER HEALTH									
28.3 Investigate naturalising concrete channel by placing rock and planting native vegetation at Chain of Ponds reserve area, where space allows.	48	0	0	0	0	0	0	$50,000	$1,500
28.5 Replace sheet piling along Cooks River, between the Undercliff Bridge and the footbridge at Flinders Road with more natural bank stabilisation where possible.	49	0	0	0	0	0	0	$200,000	0
28.7 Replace concrete embankment along Muddy Creek near White Oak Reserve with rock/vegetation and link to the adjacent reserve.	80	0	0	0	0	0	0	$200,000	$5,000
28.9 Naturalise concrete stormwater channel through Parry Park by placing rock and planting native vegetation.	130	0	0	0	0	0	0	$75,000	0
28.10 Narrow Alexandra Canal with islands and bank extensions from Canal Rd as proposed in Alexandra Canal Water Management Plan.	146	0	0	0	0	0	0	$2,000,000	$2,000
28.11 Dechannel 250m section of stormwater channel between the head of Alexandra Canal and Sydney Park as proposed in Alexandra Canal Water Management Plan.	147	0	0	0	0	0	0	$1,000,000	$1,000
TOTAL		$11,000	$30,000	$43,000	$301,700	$10,000	$301,700	$3,825,000	$246,200

Table 9.15b: Stormwater Management Implementation Program – Sydney Water (Level 2 Actions)

Action	Rank	Financial Year and Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
7.11 Provide gross pollutant interceptor/GPT near pipe outlet of Mascot West SWS or further upstream where accessible for maintenance.	131	$5,000	$100,000	$10,000
7.12 Provide gross pollutant interceptor near pipe outlet of Munni SWS upstream of proposed dechannelistation works.	132	$5,000	$200,000	$20,000
7.16 Investigate provision of offline GPT or wet pond system on vacant land at bend in Cooks River adjacent to Dean Reserve, Strathfield.	136	$5,000	$250,000	$20,000
7.17 Provide GPT/wetland downstream of Hume Highway along Greenacre Park SWS.	137	$5,000	$125,000	$15,000
7.19 Provide gross pollutant trap/interceptor at a suitable and accessible location upstream of Botany Rd SWS pipe end.	142	$5,000	$250,000	$25,000
7.20 Provide gross pollutant interceptors at pipe outlets (approx. 3) to Cup and Saucer Creek at industrial area near Alfred St, Campsie.	143	$5,000	$75,000	$20,000
7.23 Determine feasibility of providing gross pollutant traps on pipe outlets (approx. 3) to Cox's Creek near King Georges Rd, Greenacre or combined (wetland) facility in the parkland on the northern side of the canal.	152	$5,000	$150,000	$30,000
NUTRIENTS AND BACTERIA				
13.4 Construct small wetland above the tidal limit at Heynes Reserve, Canterbury to receive flows from Cup and Saucer canal.	101	$5,000	$150,000	$15,000
13.5 Investigate feasibility of installing a constructed wetland in Cooke Park downstream of Madeline Street, or upstream of Madeline Street in Begnell Park.	102	$5,000	$250,000	$15,000
13.6 Construct offline wetlands or pond system adjacent to Muddy Creek in White Oak Reserve.	103	$5,000	$250,000	$15,000
13.7 Construct offline wetland upstream of tidal limit on Omaha Canal.	104	$5,000	$200,000	$15,000
13.9 Replace concrete lined canal through Hughes Park, Canterbury with linear wetland or pool/riffle sequences along this reach of Cup and Saucer Creek.	116	$5,000	$150,000	$15,000
13.11 Trial the creation of wetlands in the upper sections of Alexandra Canal as proposed in Alexandra Canal Water Environment Plan.	144	$5,000	$3,000,000	$2,000
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	0	0	0
HABITAT LOSS AND RIVER HEALTH				
28.2 Dechannelise the concrete drain between the head of Alexandra Canal and Green Square (lower Sheas Creek) as proposed in Alexandra Canal Water Management Plan.	13	$1000	$10,000	0
TOTAL		$66,000	$5,160,000	$217,000

Table 9.16a: Stormwater Management Implementation Program – Railways (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
4.1 Develop and implement a planning policy requiring GPT and/or litter interceptors to be installed (and maintained by the development), in new commercial, industrial and shopping centre developments and redevelopments.	29	$3,120	0	0	0	0	0	0	0
4.2 Implement a policy for new commercial developments and redevelopments to install adequate and appropriately designed bins.	36	$3,120	0	0	0	0	0	0	0
1.4 Stencil Drains to educate people on the link between their backyard and the waterway and make drains readily identifiable (ie. through numbering).	58	0	0	$1,920	0	0	$2,400	0	$2,400
NUTRIENTS AND BACTERIA									
8.1 Introduce a planning policy to ensure that adequate facilities such as car washing areas are provided for new developments, including units, residential, commercial and industrial.	15	$1,870	0	0	0	0	0	0	0
10.1 Review procedures of maintenance crews and park managers in regard to disposal of grass clippings and plant material from maintenance strips and parks. Make any required changes to procedure and educate and enforce implementation.	53	0	0	$6,240	$3,120	0	$3,120	0	$3,120
8.4 Incorporate in planning controls a policy requiring car washing facilities to be connected to sewer (refer to Strathfield Council model).	111	0	0	$6,240	$3,120	0	$3,120	0	$3,120
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$4,800	$2,880	0	$2,880	0	$2,880	0	$2,880
15.2 Review weed management strategies in Parks and identify opportunities to reduce spraying through revegetation or improved practise.	75	0	0	0	0	0	0	0	0
14.4 Encourage the installation of on site detention facilities where feasible within industrial and business properties for water reuse.	77	0	0	$20,000	0	0	$10,000	0	$10,000
14.5 Audit connections from industrial areas to stormwater and implement policies to ensure connections are reviewed on sale, or for any new or redevelopments.	81	0	0	0	0	$25,000	0	$25,000	0
MANAGERIAL									
19.1 Identify and map ownership of all government land within the Cooks River Catchment and agree responsibilities between land managers in the catchment.	3	$5,000	0	0	$5,000	0	$5,000	0	$5,000
18.1 Councils to incorporate detention basins, rainwater collection tanks(where practicable), limiting % of land areas that can be surfaced, and setbacks into planning requirements for new and re-development applications.	7	$6,240	0	0	0	0	0	0	0
19.2 Define and agree responsibilities for stormwater and catchment management within Cooks River based on Action No. 90.	17	$5,000	0	0	0	0	0	0	0
18.3 State agencies to ensure stormwater management policies for developments (such as the M5 Motorway, Rail Yard redeveopment and Airport expansions etc.) are consistent with Council planning policies and controls for stormwater management.	18	$1,000	0	0	0	0	0	0	0
17.3 Include signage with all new 'visible' stormwater management facilities to inform community of stormwater objectives, problems and solutions.	44	0	0	0	0	0	0	0	0
SUSPENDED SOLIDS									
22.1 Require construction sites to implement stormwater controls defined in the "Blue Book" (NSW Government, 1998), by incorporating requirements for the best practise techniques in all Council development approvals and building approvals.	37	$3,120	0	0	0	0	0	0	0

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
24.7 Develop erosion & sediment control plan for the exposed soil areas of Enfield Marshalling Yards. Investigate opportunities to provide buffer strips and sediment basins at appropriate locations.	78	$30,000	0	0	$15,000	0	$15,000	0	$15,000
21.2 Develop procedures to manage sediment discharges from industrial activities such as concrete cutting.	92	0	0	0	0	0	0	0	0
24.10 Develop sediment control plan for Chullora Rail Workshops to control runoff from exposed surfaces. Investigate opportunity for buffer strips and sediment basins at appropriate locations.	99	0	0	$20,000	0	0	$10,000	0	$10,000
24.11 Develop erosion & sediment control plan for Eveleigh Railway Workshops.	100	0	0	$30,000	0	0	$10,000	0	$10,000
22.3 Audit implementation and effectiveness of sediment controls on construction sites. Compliance with development approval conditions to be enforced by Council officers.	113	0	0	$12,500	0	$12,500	0	$12,500	0
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$24,000	0	$24,000	0	$24,000	0	$24,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	$24,000	0	$24,000	0	$24,000	0	$24,000
HABITAT LOSS AND RIVER HEALTH									
25.1 Incorporate setbacks of at least 10m from creeklines and 20 m from main river bank in LEPs / DCP's / planning instruments to allow re-establishment of a riparian zone.	4	$6,000	0	0	0	0	0	0	0
28.1 Investigate additional opportunities for replacement of concrete stormwater channels with more natural drainage lines based on ownership of land adjacent to the channel.	5	$3,120	0	0	0	0	0	0	0
26.1 Incorporate, preservation of existing foreshore vegetation remnants and natural waterways and land adjacent to the channel, within planning policies and development controls.	8	$2,400	0	0	0	0	0	0	0
26.2 Protect Freshwater Creek during redevelopment of the Chullora Site through appropriate planning controls and design. Continue to liaise with Bankstown Bushland Society in this process.	66	$5,000	0	0	$5,000	0	$5,000	0	$5,000
27.1 Incorporate Wolli Creek Mangroves and Saltmarsh through planning policies and bushcare regeneration programs. Investigate measures to minimise sedimentation and disturbance from railways.	67	0	0	0	0	$5,000	0	0	$5,000
27.4 Protection of Cooks River Clay Plains Scrub Forest within proposed redevelopment site at Rail Yards.	71	$5,000	0	0	$5,000	0	$5,000	0	$5,000
28.9 Naturalise concrete stormwater channel through Parry Park by placing rock and planting native vegetation.	130	0	0	0	0	0	0	$75,000	0
TOTAL		$84,790	$50,880	$96,900	$87,120	$42,500	$119,520	$112,500	$124,520

Table 16b: Stormwater Management Implementation Program – Railways (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
4.4 Investigate opportunities to install GPT's where pipes discharge to waterways.	158	0	0	0
SUSPENDED SOLIDS				
24.8 Develop erosion & sediment control plan for Cooks River Goods Yards, Sydenham.	93	$3,000	$30,000	$10,000
23.2 Investigate opportunities to install sediment controls immediately prior to all stormwater pipe discharges to waterways.	138	0	0	0
TOTAL		$3,000	$10,000	$10,000

Table 17a: Stormwater Management Implementation Program – RTA (Level 1 Actions)

Action	Rank	Financial Year and Expenditure							
		Year 1		Year 2		Year 3		Year 4+	
		Capital	Maint.	Capital	Maint.	Capital	Maint.	Capital	Maint.
LITTER									
3.3 Review mixed and recyclable waste removal program to ensure frequency and timing is adequate. Upgrade waste removal program to increase frequency of bins emptied in areas where required.	155	0	0	0	0	0	0	$2,400	$36,000
TOXICANTS									
15.1 In all areas where weed spraying is undertaken along drainage lines implement stormwater verge revegetation planting as detailed in the Sydney Water Trial (Durham, 1997).	11	$4,800	$2,880	0	$2,880	0	$2,880	0	$2,880
MANAGERIAL									
19.1 Identify and map ownership of all government land within the Cooks River Catchment and agree responsibilities between land managers in the catchment.	3	$5,000	0	0	$1,000	0	$1,000	0	$1,000
19.2 Define and agree responsibilities for stormwater and catchment management within Cooks River based on Action No. 90.	17	$5,000	0	0	0	0	0	0	0
18.3 State agencies to ensure stormwater management policies for developments (such as the M5 Motorway, Rail Yard redeveopment and Airport expansions etc.) are consistent with Council planning policies and controls for stormwater management.	18	$1,000	0	0	0	0	0	0	0
SUSPENDED SOLIDS									
23.1 Maintain and regularly clean out manholes and sediment traps. Ensure sediments are disposed of appropriately.	151	0	$24,000	0	$24,000	0	$24,000	0	$24,000
23.3 Review maintenance schedules and cleaning techniques for existing road drain sediment traps and implement improvement program. Ensure sediments are tested for contamination and disposed of appropriately.	157	0	$24,000	0	$24,000	0	$24,000	0	$24,000
TOTAL		$15,800	$50,880	$ 0	$51,880	$ 0	$51,880	$2,400	$87,880

Tables 17b: Stormwater Management Implementation Program – RTA (Level 2 Actions)

Action	Rank	Expenditure		
		Year One Investigation Cost	Year Two + Estimated Capital Cost	Estimated Annual Maintenance Cost
LITTER				
4.5 Investigate locations where trapped street gully pits could be installed along roads to trap litter and sediments.	156	$5,000	$650,000	$150,000
SUSPENDED SOLIDS				
23.2 Investigate opportunities to install sediment controls immediately prior to all Council and Agency stormwater pipe discharges to waterways.	138	0	0	0
TOTAL		$5,000	$150,000	$150,000