



Manly Lagoon and Catchment Integrated Catchment Management Strategy and Evaluation

Final Report

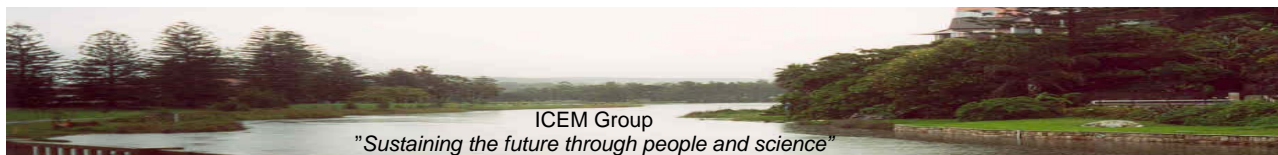
March '04



Integrated Catchment and Environmental Management Research Group

Table of Contents

1.	EXECUTIVE SUMMARY	1
2.	KEY RECOMMENDATIONS	4
	2.1 Introduction	4
	2.2 Key Recommendations	4
3.	THE MANLY LAGOON AND CATCHMENT STUDY AND EVALUATION	11
	3.1 Introduction	11
	3.2 The Strategic Inclusive Approach	11
	3.3 Key Steps in the Study and Evaluation Process.....	12
4.	MANLY LAGOON STATE OF CATCHMENT OVERVIEW.....	24
	4.1. Introduction	24
	4.2. State of Catchment Overview	28
	4.3. Indicative status and trends	33
5.	THE MANLY LAGOON ICM STRATEGY	37
	5.1. The Origin and Role of the ICM Strategy.....	37
	5.2. The catchment vision and goals	41
	5.3. The Objectives	42
	5.4. The Strategies	43
	5.5. Long Term and Medium Term Outcomes and Performance Indicators	45
	5.6. The Activities to Sustain the Catchment	49
	5.7. Information, Monitoring and Reporting Needs	49
	5.8. Recommended Additional Studies.....	51
6.	WATER QUALITY IN THE CATCHMENT.....	52
	6.1 Introduction	52
	6.2 Identify and analyse current data available in reports and databases.....	52
	6.3 Analysis and integrate available GIS information for the Catchment	58
	6.4 Review / assess quality of existing data (suitability and gaps)	59
	6.5 Analyse data and compare to water quality to be pursued, determining appropriate triggers. 60	
	6.6 Analyse Trends	61
	6.7 Identify extent of necessary water quality improvements	62
	6.8 Implications of ANZECC Guidelines	62
	6.9 Recommendations relating to ANZECC Guidelines	63
7.	ENSURING A HEALTHY CATCHMENT THROUGH AND ICM MONITORING AND REPORTING SYSTEM	65
	7.1 Overview	65
	7.2 Water Quality Monitoring.....	65
	7.3 Catchment Audit.....	66
	7.4 Community Survey.....	67
	7.5 Flow Monitoring.....	67
	7.6 Riparian Evaluation	68
	7.7 Habitat assessment.....	69



1. Executive Summary

Manly Lagoon and Burnt Bridge Creek form much of the boundary between Warringah Council and Manly Council Local Government Areas. The Lagoon lies just north of Manly and immediately behind Queenscliff Beach. Important areas of the National Estate are located in the top and bottom parts of the catchment which covers an area of approximately 1800 ha and is home to a number of threatened fauna and flora species.

The pressures of urbanisation, high population and the impacts of a wide range of activities throughout the catchment have, and continue to act to degrade the Lagoon and its feeder waterways. This general decline has generated strong community concern. Although previous initiatives to improve water quality in the Lagoon and its feeder creeks have fallen well short of their mark despite concerted efforts by government, the community still holds high expectations that appropriate action will be taken to ensure ecosystem health and water quality outcomes are consistent with their well documented values.

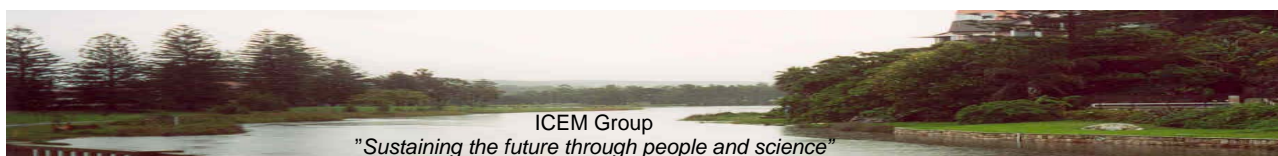
Indeed through the Sydney Water Corporation-Manly Council Partnership and community consultative initiatives, both government and the community have confirmed their commitment and desire to achieve the following outcomes for the catchment:

- aquatic ecosystem and associated wildlife protection throughout the catchment;
- secondary recreational contact (canoeing and paddling) in feeder waterways; and
- primary recreational contact (swimming) in the Lagoon itself.

Achieving these outcomes within a highly urbanised environment is a challenge of considerable magnitude. The recognition by the Partnership of the need for an ICM Strategy to provide a structured and strategic approach to catchment management, is a vital first step in what will undoubtedly be a long term process.

The Manly Lagoon and Catchment ICM Strategy and Evaluation Study was initiated and managed by the Partnership. The Study aimed to evaluate current activities in the catchment and develop a more effective approach to address the threats and causes of environmental degradation. A major product is the ICM Strategy for stakeholder review. The final ICM Strategy, if adopted, would seek to improve implementation by co-ordinating current and future management efforts to meet the community and government desired outcomes within realistic timeframes.

An evaluation of the consistency of strategic directions in current Plans and Strategies affecting the catchment revealed an overall good level of consistency of intent. However, inconsistent use of terms would have made integration of these Plans highly problematic prior to the development of the ICM Strategy. While it was likely that the highest priority actions had been identified and were being progressively implemented, there was no basis for confidence that overall 'investment' was being strategically managed to optimise benefits to the catchment.



After concluding the evaluation of current consistency, an integrated set of ICM goals, stemming from the community's long term desires for the catchment, was developed. Twenty two component strategies from existing Plans and Strategies were then refined to strengthen the likely achievement of the four long term goals and eight medium term objectives developed for the catchment and to fill identified gaps. The adequacy of the component strategies was then tested and found highly satisfactory. This was undertaken by allocating each of the 524 current and completed activities, identified from within the existing Plans and Strategies, against the most appropriate strategy. The primary focus of each activity was then assessed and recorded for inclusion in the ICM Strategy.

A desk top review of 120 publications and other documents, together with first hand inspections of the catchment by an Expert Panel, and subsequent evaluation and development of a comprehensive State of Catchment Report, has confirmed that the key issues facing the catchment relate to:

- Water cycle management, in particular stormwater discharge quality, volumes and velocities, sewage overflows, water use and reuse, and environmental flows;
- Land use management, in particular impacts of new development, contaminated land and recreational areas and use; and
- Ecosystem management, in particular impacts on riparian corridors, aquatic ecosystems and terrestrial ecosystems.

The Study has confirmed that significant opportunity exists to better optimise the water quality and quantity outcomes and other sustainability needs of the catchment by taking an integrated and adaptive catchment management approach. As part of the Study, the 524 current and planned activities aimed at sustaining the catchment's natural resources were identified from existing major Plans and Strategies. An Expert Panel evaluation of these activities concluded that, in the absence of significant change, the catchment goals would not be achieved. In fact, in such a highly urbanised catchment, there is likely to be further decline in catchment values as community activities (diffuse pollution sources) and more development continue to take their toll on the catchment's ecosystems.

However, if the recommendations in this report are pursued with commitment and vigour through an effective Community-Government partnership, then progress towards the community and government supported outcomes will be possible. A 'triple bottom line' approach is required to recognise the social, economic and environmental dimensions of the now widespread commitment to ecologically sustainable development. For example, restoration of sewerage infrastructure must be considered a priority, particularly given the importance of tourism as a driver in the Manly and wider economy. Water-based activities are heavily promoted locally, regionally and at the international level.

The ICM Strategy for Manly Lagoon catchment provides a possible solution. If adopted, it will involve the Partnership and other key stakeholders in developing and formally committing to a medium term Five Year Action Plan within the context of a longer term



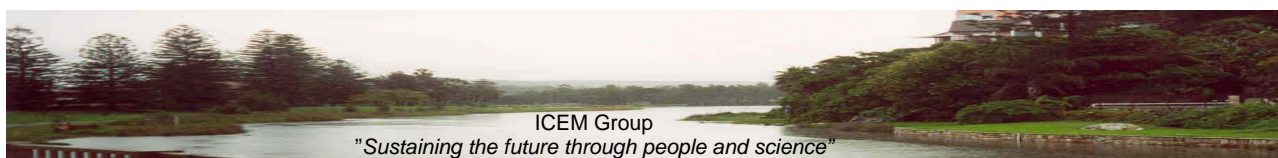
ICM Strategy. The Action Plan will focus on water quality and quantity and other key issues confronting the catchment, and would seek to overcome the key limitations identified by this study and evaluation. In five years time, contrary to the current situation, strategies to improve the catchment and consequent investment decisions would be much better informed and more likely to return greater dividends.

The ICM Strategy developed from the Study identifies four long term catchment goals based on well documented community values. Ten long term key outcome statements have been developed to guide and direct activities to pursue these goals. Forty six medium term outcome statements, each with a recommended performance indicator, have been specifically developed for the eight catchment objectives. It is recommended that these practical outcomes and indicators be immediately distilled to form the focus of an ICM Monitoring and Reporting System to better ensure delivery and progressive attainment of agreed catchment values. The System would benchmark, and then measure progress of achievement as a result of implementation and adaptive review of the ICM Strategy.

For the first time, most, if not all, of the activities of state and local government have been brought together and considered in detail against the State of Catchment. A powerful conceptual framework has emerged which, if adopted with ongoing commitment and support, is indeed capable of bringing about the level of necessary change required. It is acknowledged that this will take time, eventual achievement may even take decades. However, the ICM Strategy has the ongoing capability to respond to arising challenges and encapsulate new strategies and activities as required.

Manly Beach is an Australian icon. It is often the first welcome experience for many thousands of Australians and international visitors who come to appreciate the splendour and quality of life that is offered by Sydney's Northern Beaches area. In ten years time, the Manly Lagoon catchment could be basking along side Manly Beach in the 'sunlight' of recognised progress for sustainability. So too, could the coastal lagoons and their catchments to the north in Warringah Shire, as knowledge and experience developed in the Manly Lagoon catchment is shared through the Partnership. Most importantly, for these catchments, their natural resources and people, is that the 'light of fame' will be a true reflection of leadership and achievement in the pursuit of sustainability. It would be a direct result of well documented and widely understood real world achievements, setting a new benchmark in quality of life and coastal urban living. These benefits may then be extended to other regions via state agency partners and the natural spread of community acclaim and achievement.

Community consultation revealed strong support for the Strategy and its implementation. The comments received showed a high level of knowledge and experience and enabled considerable strengthening of the ICM Strategy and a number of key recommendations. The development of an ICM Strategy for the Manly Lagoon catchment provides a real and exciting opportunity to significantly progress the pursuit of sustainability in a coastal-urban environment. It provides both a platform and a potential turning point to better achieve the community's desires for ecosystem protection, water quality improvement and other natural resource sustainability outcomes for the catchment.



2. Key Recommendations

2.1 Introduction

The Executive Summary of this report outlines the capacity of the ICM Strategy to bring about necessary organisational and individual behavioural change for sustainability. Whether this is achieved or not, will depend upon those who are entrusted with overseeing the ICM Strategy's processes, mustering the necessary resources and co-ordinating its progressive implementation and adaptive review.

The Sydney Water-Manly Council Partnership is in an excellent position to improve the effective and efficient implementation of the 482 activities yet to be completed and identified in the ICM Strategy for Manly Lagoon catchment. Among its members are the organisations with the principal responsibilities for planning, policy, regulatory, operational and educational responsibilities, now brought together within the ICM Strategy. A decision to fully embrace and support the ICM Strategy by the Partnership would no doubt result in a much more effective pursuit of the Partnership's objectives due to the high level of complementarity.

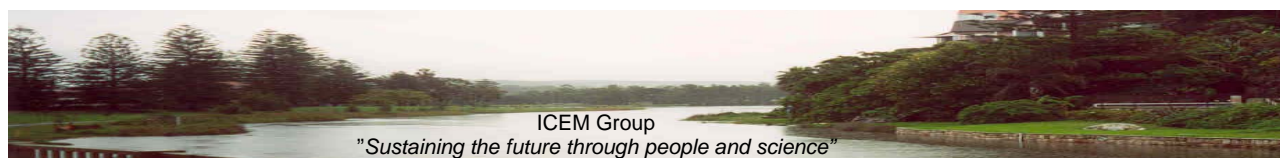
If co-ordinating natural resource management activities was an easy and straightforward task, then Manly Lagoon catchment and many others throughout NSW would be much further along the road to improved catchment health. Consequently, the recommendations given below have been developed to assist the Partnership to improve integrated implementation and adaptive review of the activities in the ICM Strategy.

The recommendations are based on the observations and results of the Manly Lagoon Catchment ICM Strategy and Evaluation Study and the long term experience of the Study Team and Expert Panel. Together, they map out a proposed pathway which will provide the Partnership with a much better chance of achieving its objectives in reasonable timeframes. Such achievement will require continuing high level commitment and support to a strategic, adaptive and inclusive approach which genuinely involves other key players as well as a wide range of stakeholders including the catchment community.

2.2 Key Recommendations

Recommendation 1: *That the principles within the Statement of Intent – Coastal Lakes developed by the Healthy Rivers Commission and endorsed by the NSW Government in April 2003 be adopted as the most appropriate basis for the Manly Lagoon and Catchment ICM Strategy.*

These principles were reviewed by the joint meeting of the Expert Panel, Partnership Task Group and community representatives held in Manly on 13th May 2003. They were considered to be the best set of guiding principles yet developed for integrated and adaptive management of coastal lagoons and catchments through partnership approaches.



Recommendation 2: *That the Statement of Intent-Healthy Modified Conditions Management Framework for Coastal Lakes (Table 3), and not the HRC recommended Targeted Repair Management Framework (Table 4) be adopted as the framework for the ICM Strategy.*

Table 3 has greater consistency with the goals, objectives and strategies recommended for the catchment and the hundreds of current and planned activities now identified in the ICM Strategy. While the logic of Table 4 correctly reflects the potential for reasonable progress from current catchment conditions, the community and the Partnership have clear aspirations that better catchment values be pursued. Accordingly, Table 3 more adequately reflects the well documented community values and it is recommended, provided the aspirations can be matched with commitment.

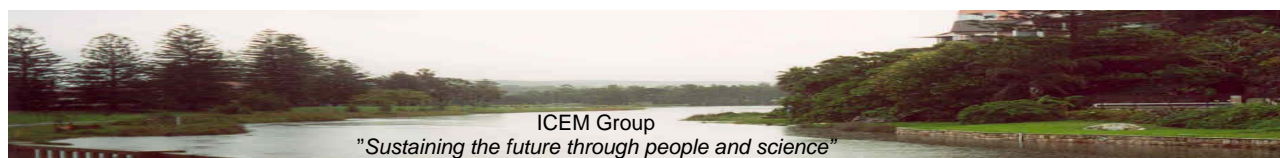
Recommendation 3(a): *That the Sydney Water-Manly Council Partnership encourage and support a catchment focused re-orientation of the Manly Lagoon Joint Estuary and Floodplain Management Committee with appropriate membership. This committee could be known as the Manly Lagoon Catchment Co-ordinating Committee and charged with initial responsibility to develop terms of reference for approval consistent with current reforms being considered and developed by the Department of Infrastructure, Planning and Natural Resources. The terms should focus principally on a co-ordinating role which enables the active, effective and efficient pursuit of an appropriate mission statement through co-ordinated implementation of the ICM Strategy.*

Experience in catchments throughout NSW has shown that where ICM Strategies are accompanied by ownership and drive by participating organisations and the catchment community, then good progress can be made towards catchment goals. Without this, strategies can lapse or remain largely ineffectual as a means of co-ordination.

Recommendation 3(b): *That the Catchment Co-ordinating Committee be independently chaired by a high profile, articulate member of the catchment community with strategic and management skills to provide effective leadership. The Chairperson should also have the communication, time management and interpersonal skills to become, and remain a well known, respected and supported champion at all levels for the sustainability needs and achievements of the catchment.*

Catchment management co-ordinating bodies have a task that some people consider to be the most difficult in the pursuit of sustainability - attempting to successfully co-ordinate work between local governments, state agencies and the catchment community. Experience in NSW and elsewhere over the past decade and half has confirmed the need for, and value of, independent Chairpersons. The benefit in having a true champion to provide a high profile public face to efforts to sustain the catchment cannot be underestimated, particularly when there is need to more fully activate community involvement and support.

Recommendation 3(c): *That within their approved terms of reference, the Catchment Co-ordinating Committee immediately utilise the products of the Manly Lagoon and Catchment ICM Strategy and Evaluation Study to refine a Five Year Action Plan.*



The optimal approach recommended by this Study is to pursue with vigour and commitment a Five Year Action Plan. The Plan would be refined from the ICM Strategy and the 482 activities already incorporated within the Strategy. It would optimise the benefits of the Plans and Strategies on which it is based (including the Catchment Blueprint, Sydney Northern Beaches Stormwater Management Plan, the combined Estuary and Floodplain Management Plan and a number of local plans of both Warringah and Manly Councils).

An investment of \$45 million by Sydney Water Corporation to upgrade sewerage infrastructure over the next five years should result in wet weather overflows being dramatically reduced to no more than two events per year over any ten year period. Most importantly, the Five Year Action Plan would add considerable value and optimise benefits to water quality to such an investment by Sydney Water Corporation.

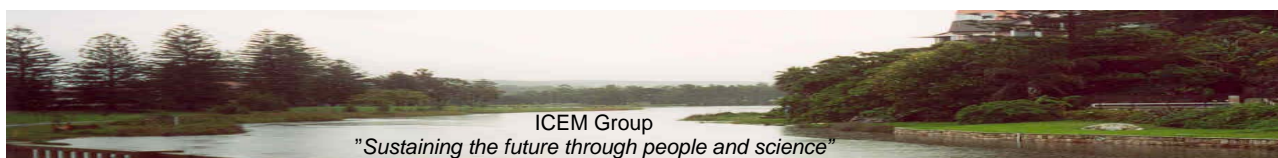
Recommendation 3(d): That the Catchment Co-ordinating Committee adopt a Management Cycle approach in co-ordinating catchment activities to better achieve the objectives of the Manly Lagoon ICM Strategy.

One of the most significant limitations of the current activities aimed at sustaining the catchment's natural resources and values is the lack of evaluation. Undertaking the Five Year Action Plan using a Management Cycle approach, as outlined in this Study, offers a real prospect of improved outcomes and more cost effective investment. Annual reviews of implementation should be undertaken to maintain a high level of accountability and provide opportunities for committee members to share insights, experience and resources where appropriate to help overcome challenges and short comings. Achievements should be celebrated with the catchment community.

Recommendation 4: That the Partnership develop and effectively resource an ICM Monitoring and Reporting System, which embraces the current National Water Strategy Guidelines and is capable, in a cost-effective manner, of identifying 'hot spots,' measuring change in a selected suite of key performance indicators and clearly and appropriately communicating results and achievements to catchment managers, decision makers and the catchment community.

To achieve this recommendation, mechanisms for cost-sharing will need to be identified, negotiated and agreed. This would enable practical and sustainable resourcing needs of integrated monitoring across stakeholders to be met. This would then enable the ICM Monitoring and Reporting System to provide the means to integrate biological and physico-chemical monitoring with local hydrological dynamics, (including velocities, hydrograph characteristics and related water quality/quantity dynamics), and impacts on aquatic, riparian and terrestrial ecological associations.

The System would draw upon the National Water Quality Guidelines (by adopting the Study's eight additional recommendations in Section 6.9), identify 'hot spots' and targets for remediation, the relevance of waterway status in relation to the community values and the level of improvement required. It would also allow existing and new monitoring data to be located in relation to catchment influences and weather events.



Recommendation 5: *Integrate the suggested suites of condition and performance indicators, along with their attributes, within a hierarchy of sustainability indicators, to complement and refine outcomes identified for goals and objectives of the Manly Lagoon ICM Strategy.*

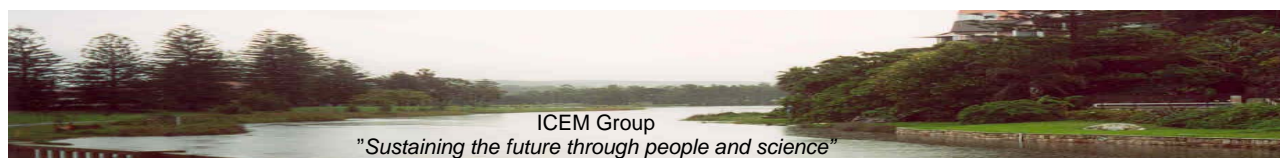
A hierarchy of indicators within the ICM Monitoring and Reporting System should place decision makers in a clear position to identify the relative benefits of the activities undertaken and their contribution to catchment objectives. At the end of the Five Year Action Plan, unlike at the present time, there should also be an improved understanding of the scale and nature of the additional investment required to achieve the catchment goals and the likely timeframes to achieve this. The current absence of benchmarking and formal mechanisms for evaluation may be resulting in less appropriate priorities, a lack of targeting of resources and / or management interventions.

Utilising the hierarchy of indicators in the medium and longer term, the monitoring system should be capable of measuring the cost effectiveness of various approaches to bring about change from initially benchmarked conditions. As such, the ICM Monitoring and Reporting System would, through time, become a tool of active learning and an important informational source for adaptive management. Its utility will be enhanced by simply informing the catchment community and other stakeholders of change and success through web-based and other suitable communication means. A suite of communication strategies could also promote informed involvement in monitoring and share results in ways adapted and targeted to different audiences.

Recommendation 6: *Further resolve some of the uncertainty and variability in the likely catchment responses to improved practices by routine use of concurrent water quality modelling as a tool.*

The benefits of having the ICM Monitoring and Reporting System should be capitalised upon by having monitoring and modelling proceeding in tandem. By having good liaison and joint work taking place, the benefits of modelling will be greater than if monitoring precedes modelling as is too often the case. By way of example, the TCM Management Framework developed by Manly Council, which includes monitoring, modelling and a treatment train approach (see Volume 2 of this report), provides a very useful starting point for an integrated approach to monitoring and modelling.

The development of integrated monitoring and modelling will be critical in facilitating and measuring successes to achieve water quality improvements. Included in this approach would be appropriate modelling of Manly Lagoon required to understand Lagoon responses to pollutant loadings and remedial interventions. Modelling can enable the development of a shared understanding of critical dynamics and help to form an improved basis for predictive testing of interventions.



Recommendation 7: *That resources be found to undertake the following additional studies which have been identified as priorities through this Study:*

The determination of the nature and relative contribution of exfiltration and infiltration in private sewer lines to water quality decline in the catchment;

The determination of the nature and relative contribution of contaminated lands, particularly the old tip sites, to ground water degradation;

The impact on water quality in Queenscliff Pool of discharges from Manly Lagoon which are currently below standards for Primary Recreation;

The results of these three studies in particular would significantly assist the further development of the ICM Strategy and future investment decisions.

Recommendation 8: *Address high stormwater velocities as a high priority within the ICM Strategy.*

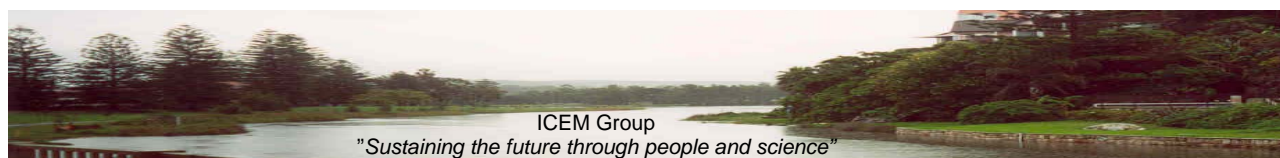
The Study has confirmed there is clearly a need to slow down the flows arising from heavily paved areas of the catchment. The understanding of catchment processes developed through the Study has revealed that high and continued velocities of stormwater entering the waterways is contrary to the pursuit of the objectives relating to the protection of aquatic ecosystems – arguably the most desired community value. The percentage of hard surfaces (roads, paths, driveways and roofs) in most of the sub-catchments is well beyond the level which maintains stormwater run-off and velocities below threshold levels.

While the transition to use stormwater as a resource provides an excellent long term opportunity to resolve this problem (and other issues like reducing water demand across the Sydney Metropolitan Area), the opinion of the Expert Panel was that this strategy was not likely to bring about the level of necessary change quickly enough. It is recommended that an initial focus on detention, to cut the peak of the hydrograph, is more likely to gain results quicker, especially using the opportunities of new development as these arise. As with all strategies in the ICM Strategy, refinement should be based on cost effectiveness and likelihood of adoption.

Recommendation 9: *If necessary, resolve with the community the issue of overcoming wet weather impacts on primary contact recreation water quality standards in Manly Lagoon by clarifying the scale of investment required.*

The Study has found that, given current planned levels of investment, that the primary recreation contact goal for Manly Lagoon is not achievable in such a developed catchment. Should the community consultation with the ICM Strategy confirm significant dissatisfaction with the likely long term outcome then the Partnership should identify necessary works and funding.

Depending on the depth and breadth of community feeling the Partnership could either arrange one or a number of meetings to inform the community of the magnitude (probably in the order of hundreds of millions of \$'s) that would be required to move forward. Consideration could also be given to a more comprehensive process of



community involvement in the cycle of assessment as outlined in this report. Previous experience with this process in the Streamly Clean Project in the Upper Parramatta River Catchment was that it considerably assisted the community to focus on what they really wanted and what they were prepared to pay.

This action is required to assist the community to understand what is required and decide what a higher level of attainment will mean and cost.

Recommendation 10: *As part of the refinement process of the ICM Strategy, consideration be given to the development and resourcing of a catchment wide Community Awareness and Involvement Initiative.*

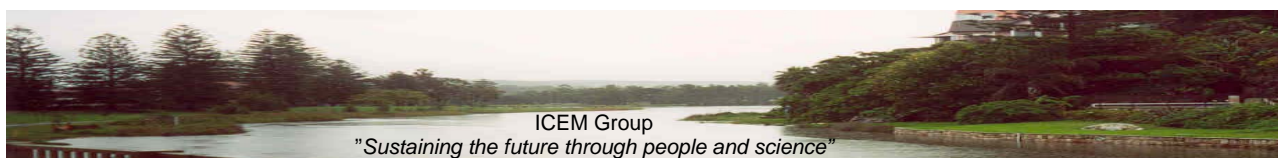
There is a critical need within the catchment to build upon the already existing high level of community interest and concern. Diverse efforts by the community need to be recognised and supported. Achievements by both community and government need to be marketed, particularly runs on the board in terms of progress towards catchment goals and objectives. The pursuit of sustainability needs to become a larger, everyday part of the lives of the people who live, work and play in the catchment. Without this, there is probably not the level of engagement and commitment across the catchment to deliver the outcomes desired by the community.

Recommendation 11: *That as a high priority Manly Council and Warringah Council work together to develop a consistent set of objectives and provisions for incorporation within their respective Local Environmental Plans (LEPs).*

Following research and consultation with Catchment Managers at the regional scale, appropriate indicators or measurable parameters for development control should be identified and/or developed by the Councils in consultation with the Committee. These could then form the basis of objectives and provisions for revised LEPs and DCPs. There is a crucial need to enable improved assessment of Development Applications consistent with the intent of the goals and objectives of the ICM Strategy. Such an approach was strongly supported by the community review process. However it requires commitment by all parties to identify provisions capable of application at the DA stage.

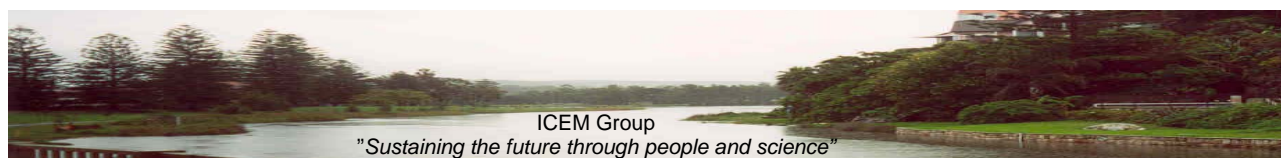
It will be important for Councils to work with the recently proposed Catchment Management Authority to build capacity as well as to identify and promote implementation of practical Development Control principles across the catchment. Emphasis should continue to be placed on implementation of the Catchment Blueprint which provides the overall strategic framework for the Manly Lagoon and Catchment ICM Strategy.

BASIX and the *Water Sensitive Planning Guide* are critical documents that should be referred to by Councils in their research. When a DA is submitted to Council, a development control officer would not know how to appropriately determine the impact of a single development on the wider catchment. The *Water Sensitive Planning Guide* for the Sydney Region is a planning guide that aims for urban development design to be complementary to the natural water cycle. It places an emphasis on the importance of on-site collection, treatment and utilisation of water flows. The guide provides Councils



with practical guidance on how to promote Water Sensitive Urban Design at planning and DA stages of development. The guide is further compatible with BASIX.

BASIX - The Building Sustainability Index was developed by DIPNR as a comprehensive sustainable building tool to assist architects, builders and developers to address the following sustainability indices: Water; Stormwater; Energy; Indoor amenity; Landscape diversity; Recyclables and Waste; Materials; Transport and Social. BASIX comes into force for all new residencies in the Sydney Metropolitan area in July 2004 and NSW wide in July 2005.



3. The Manly Lagoon and Catchment Study and Evaluation

3.1 Introduction

The Manly Lagoon and Catchment ICM Strategy and Evaluation Study was initiated and managed by the Sydney Water and Manly Council Partnership. The Study was developed and undertaken by a team of senior members and associates of the Integrated Catchment and Environmental Management Research Group at the University of Western Sydney.

The research and consultancy activities were originally planned and scheduled to be undertaken between April and December 2002. However, in late 2002, other studies relating to proposed Manly Lagoon rehabilitation works were being undertaken by Patterson and Britton Pty Ltd on behalf of Warringah Council. Accordingly, all members of the Partnership agreed that the work plan be extended to enable inclusion of the information developing from these other studies.

Awaiting the results of Patterson and Britton's environmental review work relating to the Lagoon fortuitously enabled the developing ICM Strategy to embrace and incorporate newly emergent and revised State and Local Government planning initiatives during the first half of 2003. As it currently stands, the ICM Strategy now incorporates each of the principal State and Local Government plans relating to the area as well as the latest initiatives in sustainability planning and action.

3.2 The Strategic Inclusive Approach

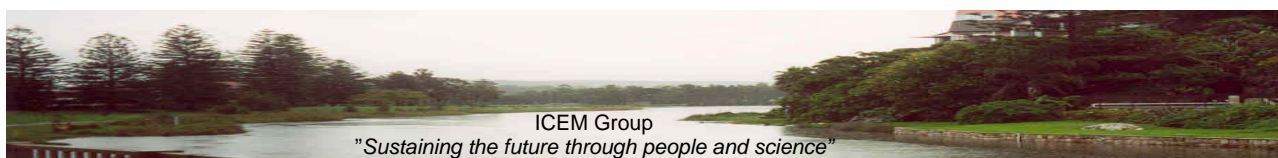
The approach used to undertake and develop the ICM Strategy for the catchment was strategically based from the outset. It commenced with the identification of the following broad strategic intent for the initiative:

Water quality in Manly Lagoon and its feeder streams become capable of sustaining healthy natural ecosystems and enable swimming and secondary contact recreation respectively in these waterways.

A goal for the ICM Strategy itself was developed and presented to the Partnership for approval. This interim goal was:

An ICM Strategy that would demonstrate how the pursuit of the above intent could be significantly progressed by identifying realistic interim objectives, the means to their achievement and the measurement of their progress.

From this base, the Study pursued a series of logical and strategic steps consistent with the team's response to the project brief. As with the goal, the proposed work plan and key study processes were presented to and endorsed by the Partnership Committee at a meeting in Manly on 20th June 2002.



A second briefing was given to the Partnership at a meeting on 26th September 2002. At this meeting a more fully developed draft Strategic Framework, including proposed goals, objectives and strategies, was presented and endorsed by the Partnership. An overview assessment of the strategic consistency of existing plans and their integration was also presented to the meeting, along with the results of a Rapid Search, Assessment, and Management Tool for Manly Lagoon catchment. An early draft of the information pertaining to State of Catchment was also presented on a sub-catchment basis and deemed appropriate for the Study.

3.3 Key Steps in the Study and Evaluation Process

Identification of Key Information and People

The study commenced with the identification of all relevant documents, data bases and statements relating to Manly Lagoon catchment within councils and agencies. A large number of document listings were received via the Project Manager. To ensure completeness, the resulting bibliography was circulated to members of the Partnership Task Group for review and to check for additional information in Council and Agency libraries (including the Manly Environment Centre and Coastal Environment Centre). Key individuals were also identified and contacted within each organisation and, where appropriate, additional people with relevant knowledge and experience were contacted. In all 120 publications and other documents were overviewed and relevant information extracted to identify the situation, responses and State of Catchment.

Development of ICM Strategy Vision, Goals and Principles

An initial Draft Strategic Framework was developed including key principles (such as continuous improvement, inclusive and adaptive approaches to management). This was followed, drawing upon previous community consultation, by the development of a draft vision as an integrated set of catchment values expressed as long term goals (desired states or outcomes). The vision and goals were then considered and refined at the June meeting with the Partnership. A review of the National Water Quality Strategy documents was later carried out to provide triggers for appropriate parameters consistent with the goals (see Chapter 6).

Consistency of Current Strategic Directions

At the September meeting of the Partnership, a brief overview was presented based on detailed review of the goals, objectives strategies and actions within the reviewed reports and documents. At that time the principle Plans and Strategies that had been identified as relating to the catchment were:

- Sydney Harbour Catchment Blueprint;
- Estuary Management Plan;
- Floodplain Management Plan;
- Sydney Northern Beaches Stormwater Management Plan;
- Draft District Plan of Management;
- Burnt Bridge Creek Restoration Management Plan;



- Allenby Park Plan of Management;
- Manly Council Sustainability Strategy;
- Manly Warringah War Memorial Park Plan of Management
- Manly Council and Warringah Council Management Plans.

Subsequently, activities from the following additional Plans and Strategies were also evaluated:

- Manly Council Blueprint Local Implementation Plan
- Warringah Council Blueprint Local Implementation Plan
- Warringah Council Creeks Strategy

It was observed that while there was apparent consistency in terms of broad thrust, intent and identified outcomes across the different Plans and Strategies, there was still considerable difficulty in trying to bring them together because of highly inconsistent use of terms. What was an action in one plan, was an objective or strategy in another. Such inconsistencies provide considerable challenge for program management and co-ordination and so all inconsistencies were sorted through using the following widely used Total Catchment Management simplified strategic planning terms:

Goal: *What do we want? (long term desire)*

Objective: *What can we achieve? (medium term quantitative outcome)*

Strategy: *How do we go about this? (collective strategic activities statement)*

Action: *What is to be actually done, where and when and by whom.*

When attempting to bring the current strategic directions and activities together, a number of inconsistencies were highlighted. In some cases several strategies were identified to pursue objectives, but there were no identified actions. While in other cases, actions had been assigned a priority within quite specific contexts, yet no priorities had been assigned according to catchment goals and objectives. Further and importantly, while it was likely that the highest priority actions had been identified and implemented there was no basis for confidence that the overall 'investment' was being strategically managed to optimise benefits to the catchment.

The Integrated Strategic Approach

After concluding the review of consistency of current strategic directions, an integrated set of ICM goals stemming from the community's long term desires for the catchment was developed. Twenty two component strategies were then shaped to strengthen the likely achievement of the catchment goals and objectives and to fill identified gaps. The adequacy of the component strategies was then tested by allocating each of the 524 activities identified to-date in the existing Plans and Strategies against the most appropriate strategy. At the same time, the primary focus of the activity was assessed.



This was recorded as either:

- Education and Awareness;
- Improved Practices;
- Planning and Policy;
- Partnerships; and
- Information or Monitoring and Assessment.

The results of this assessment are shown in Tables 3a and 3b on the following pages for current (planned, initiated and ongoing) activities and completed activities respectively.

Table 3a Assessment Results – Current Activities within each of the 22 strategies within the Manly Lagoon ICM Strategy

ICM Sub-Strategy	Education, Awareness, Involvement	Improved, Practices	Planning, & Policy	Partnerships	Information	Monitor & Assess	Total	%
1. Broad based education and support.	25	1		1			27	6%
2. Integrated approaches to catchment management	1	1	8	3	1	2	16	2%
3. Integrated monitoring frameworks	2		2	2	2	7	15	3%
4. Sources of pollution	5	3	5		2	1	16	3%
5. Enforcement and assessment activities		1	2				3	1%
6. Infiltration, water conservation & re-use	5	2	2	1	3		13	3%
7. Erosion and sediment control	3	6	8		3		20	4%
8. Stormwater management	13	39	14	2	8	8	84	17%
9. Sewer management	1	6	2	4	2	5	20	4%
10. Lagoon tidal exchange and flows		5			1	4	10	2%
11. Lagoon flooding & water quality	1				2	4	7	1%
12. Environmental flows & groundwater			6	1	3	1	11	2%
13. Creek channels and banks		7	13			1	21	4%
14. Stormwater impacts on bushland		1	1				2	1%
15. Stormwater and public safety	2		1				3	1%
16. Recreation access & facilities	5	8					13	2%
17. Weeds and feral animals.	4	9	7		1	1	22	4%
18. Bushland habitats & corridors	8	11	16	1	9	2	47	9%
19. Riparian corridors & water ecosystems	9	13	20	3	9	6	60	12%
20. Landuse impacts on biodiversity	3		37	1	5	2	48	10%
21. Manage & conserve cultural assets	2	2	3	3		1	11	2%
22. Education on cultural values & sites	6		4		2	1	13	2%
Totals and percentages	95 (20%)	115 (24%)	151 (31%)	22 (5%)	53 (10%)	46 (10%)	482 (100%)	100%

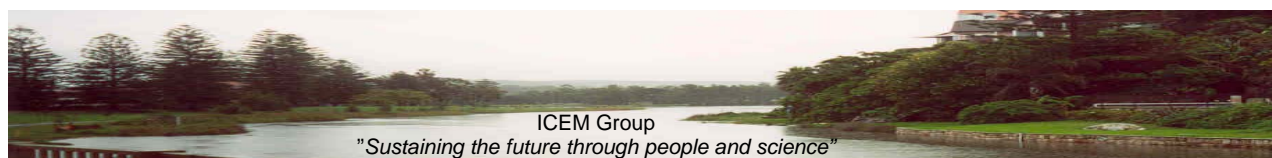


Table 3b Assessment Results – Completed Activities within each of the 22 strategies within the Manly Lagoon ICM Strategy

ICM Sub-Strategy	Educ ation, Aware ness, Involve ment	Improv ed, Practic es	Planni ng, & Policy	Partne rships	Inform ation	Monito r & Assess	Total	%
1. Broad based education and support.	2						2	5%
3. Integrated monitoring frameworks					1		1	2%
4. Sources of pollution						3	3	7%
5. Enforcement and assessment activities			1				1	2%
7. Erosion and sediment control			1				1	2%
8. Stormwater management		12				1	13	31%
9. Sewer management				1		1	2	5%
10. Lagoon tidal exchange and flows			1		1	3	5	12%
11. Lagoon flooding & water quality					2		2	5%
18. Bushland habitats & corridors					1		1	2%
19. Riparian corridors & water ecosystems			3		2		5	12%
20. Landuse impacts on biodiversity			4		1	1	6	14%
Totals and percentages	2 (5%)	12 (29%)	10 (24%)	1 (2%)	8 (19%)	9 (21%)	42 (100%)	100%

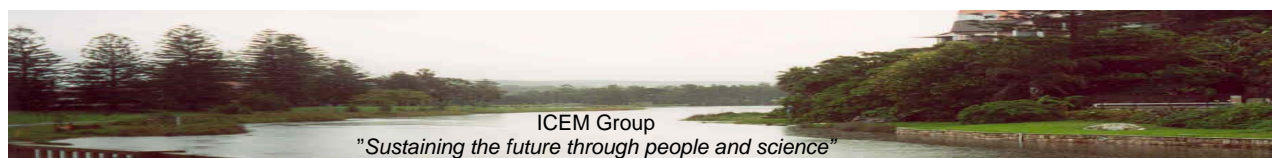
Of the 482 activities which were identified as still current, 84 (17%) related primarily to stormwater management and 60 (12%) to riparian corridors and water ecosystems.

Only 42 of the 524 activities identified in the current Plan and Strategy documentation were identified as completed by members of the Partnership.

A complete listing of the 524 activities along with their evaluation is presented in Volume 2 of this Report. The evaluation includes:

- activity status (either planned initiated, ongoing or complete);
- organisation with prime responsibility for implementation;
- other supporting organisations ;
- estimated cost and resourcing level (where available); and
- proposed timeframes for completion (either 03/04; 04/07 or beyond 07).

The timeframes were selected to be complementary to Councils' Management Plans. Following input from the Expert Panel (which was formed to provide specialist input and support the evaluation), a final integrated set of long term ICM goals and a consistent set of medium term objectives were developed.



Evaluate State of Catchment

The State of Catchment Evaluation was undertaken as a desk-top study. The process involved initial development of a bibliography of published and unpublished reports; identification of major documents for both report preparation and strategy development; documentation of community values, and concerns; and identification of key issues. Information on the current state of the key issues and the pressures on them were then summarised for each sub-catchment from the many reports available and response information collated from a further series of documents. Full catchment overviews for each issue were then prepared based on the sub-catchment analyses of the current situation and an assessment of the response activities already undertaken, continuing and planned. Data gaps were identified and also what else could be done to improve the situation. These were developed into a list of activities to be considered further by the Expert Panel and subsequently by stakeholders.

The sheer volume of information available on the Manly Lagoon catchment made the collation and assessment of it very difficult. The sub-catchment areas drained by the three main creeks and the estuary-floodplain area differ considerably in characteristics and it was considered important that these differences were not lost through aggregation of the data. Also, it is considered that a sub-catchment approach provides a more strategic framework for decision-making and management action; a better basis for community interaction with managers; and engenders greater community interest and involvement in remedial action.

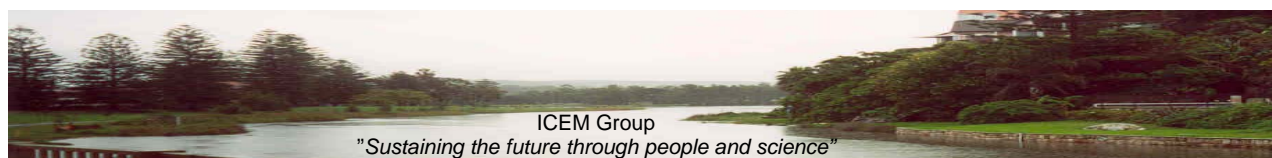
Community values for the area have been clearly expressed and community concerns were taken into account in the preparation of the State of Catchment report, which has confirmed the following key issues:

- **Water cycle management:** stormwater system and run-off; sewage and water use; water flow
- **Land use management:** development; contaminated land; recreation
- **Ecosystem management:** riparian corridor; aquatic ecosystems; terrestrial ecosystems

The State of Catchment Overview (Chapter 5) also documents two key processes, catchment health monitoring and increasing community awareness, knowledge and involvement. Volume 2 of this Report provides a more detailed outline of the methods used in compiling the State of Catchment report, further discussion of the value of the sub-catchment approach, summaries of the information collated on each key issue, a list of the references used and a bibliography.

Evaluate Consistency of Current Plans and Actions

A comprehensive listing of current and planned activities (programs, projects and policies) was identified from existing plans. These included wide ranging activities covering sewerage and stormwater infrastructure, general works, planning, enforcement, monitoring, education and awareness.

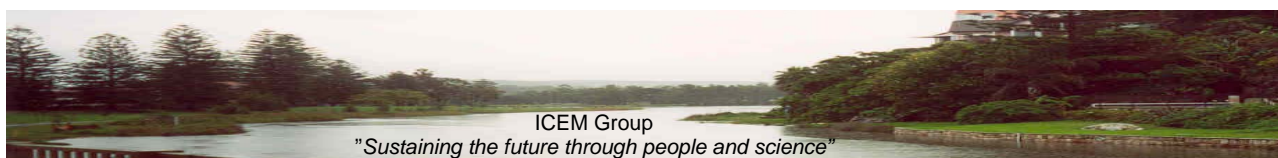


Further details of the evaluation of current activities are presented in the State of Catchment Report in Chapter 5 which provides an assessment of the 'indicative status' and 'indicative trends' over the next 5 years- extrapolated from the information available. The State of Catchment Section in Volume 2 of this Report summarises the current and planned activities.

There are literally, hundreds of current activities, some of which could be viewed as well targeted, quite leading edge initiatives. Many others however, are not as well targeted as they could be. Given the large number of activities, and a general absence of performance data available, it was not possible to evaluate the appropriateness or effectiveness of individual activities. This task can however be undertaken in the future, provided improved monitoring and reporting take place. However, given the State of Catchment and the large number of activities involved, it is likely, as with many other catchments, that a lack of consistency exists in the way different activities are implemented. It is likely that without a catchment wide management cycle approach, a large number of these activities are likely to continue to be implemented in ways that do not optimise potential outcomes.

While performance indicators and other assessment measure are present in most of the current Plans and Strategies impacting on the catchment, it was generally assessed that these were inadequate. Many actions are uncompleted (482 out of 524) and assessment of them is almost always entirely qualitative. The essential need is for quantification of progress. The most detailed set of quantitative performance indicators were presented in the Stormwater Management Plan. While appropriate and comprehensive, these indicators were of little use as they often related to desired percentage improvements and there was neither identified benchmark data nor matching data set being collected to assess progress.

These observations reinforced the need to undertake activities in the catchment management cycle approach with a corresponding Integrated Monitoring and Reporting System. Such a proposal would cover all plans incorporated in the ICM Strategy. An example of the simple management cycle envisioned for the catchment is shown in Figure 1. In this instance the management cycle relates to Water Quality, although there is no reason why an integrated set of catchment values, as in the case of the Manly Lagoon ICM Strategy, could not form the key focus.



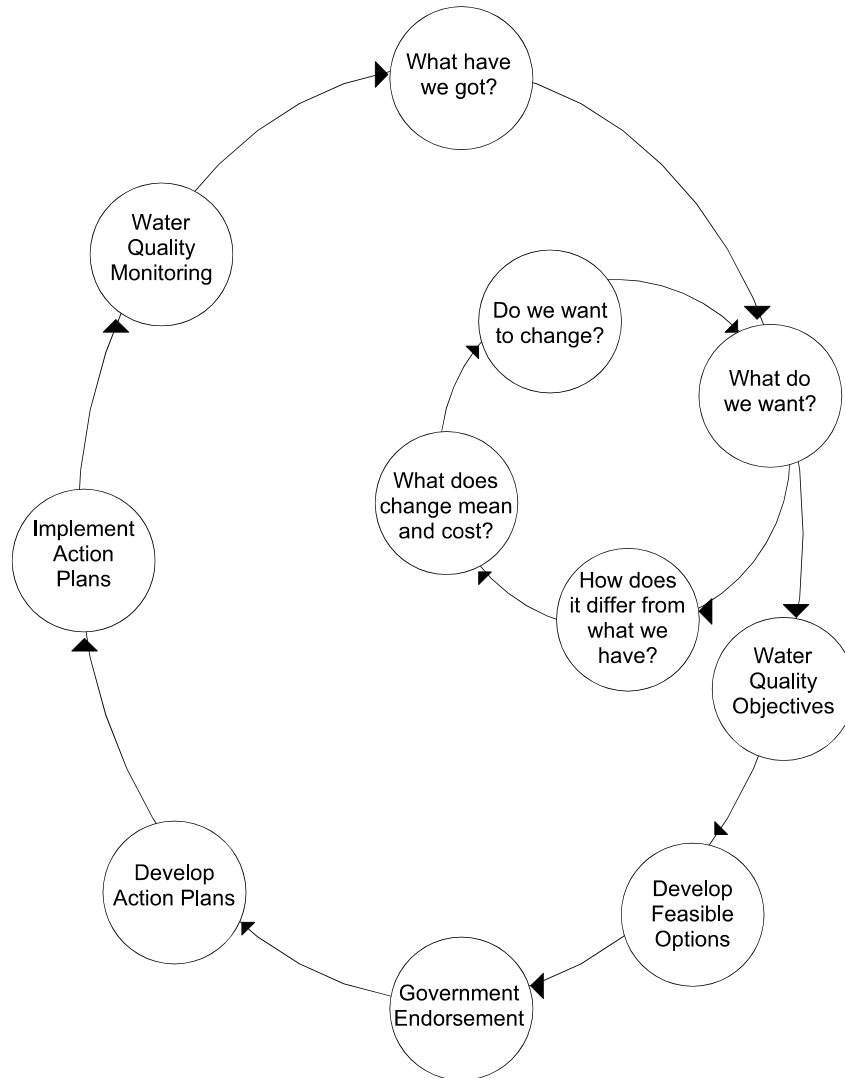


Figure 1 Water Management Cycle



The Water Quality Management Cycle was raised at the second meeting of the Expert Panel which was held jointly with members of the Partnership Task Group and the catchment community. The many benefits of the management cycle approach were outlined, including the value of involving the catchment community in the 'inner cycle'. It was considered that this may be a very worthwhile exercise to be undertaken in the Manly Lagoon catchment at an appropriate time.

Where the 'inner cycle' has been undertaken elsewhere, such as in the Upper Parramatta River Catchment, the community has come to a much better understanding of what it means and costs to achieve the desired level of water quality. In the case of the Upper Parramatta River Catchment, the community revised its desires based on too high a cost for their initially desired levels of water quality. Of greater significance, though is that the process of engaging the community in a comprehensive involvement process can significantly raise awareness and galvanise greater effort in support of the catchment goals and objectives.

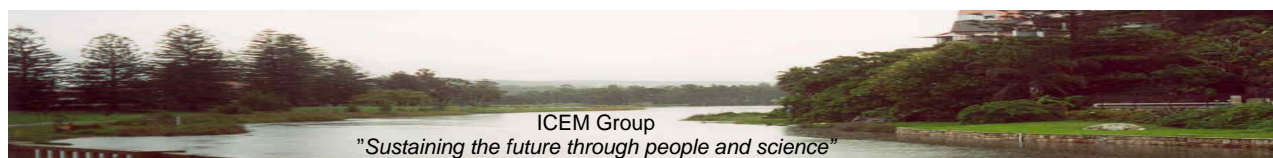
Considerable efficiencies can be attained by effectively co-ordinating the collection and sharing of data collection in the catchment. By benchmarking key performance indicators at the commencement of the Strategy and ensuring that ongoing monitoring is undertaken, then in both the medium and longer term, the benefits and cost effectiveness of activities should be made much clearer. Through time this will lead to considerable improvements in decision making and as 'returns' from investing in different strategies are able to be evaluated. More particularly, decisions in future years regarding the need or otherwise for additional investment would have a much more tangible basis.

Understanding of Catchment Processes

As outlined previously an Expert Panel was formed specifically to assist in the development of the ICM Strategy and Evaluation. The terms of reference for the Panel and its membership are found in Volume 2 of this report. Specialist input and advice was engaged to ensure the development of a 'state of the art' Strategy. The Panel met on three occasions, two of its meetings were also attended by community representatives and Council and State Agency members of the Partnership.

At its first meeting on 9th May 2003, the Expert Panel was provided with material and briefings on the ICM Strategic Framework, the state of catchment and sub-catchments and catchment processes. Information was also provided on the current situation with key issues facing the catchment and the responses. Given the particular importance of water quality issues in the catchment, presentations were also given by Sydney Water Corporation on its sewer management activities and by Mr Geoff Hunter on stormwater management. Mr Hunter is one of Australia's leading practitioners in sustainable stormwater management and is also very familiar with the catchment, its water quality and quantity issues and the actions taken to address these.

As a result of this meeting a much clearer and consistent picture emerged regarding catchment processes and how they are impacting on the community's desired values.



This understanding has been incorporated into the State of Catchment analyses found in Chapter 4.

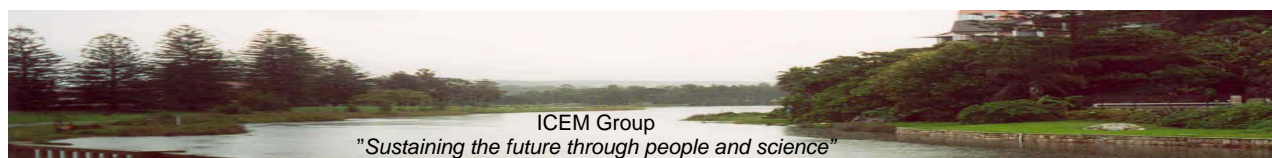
However, of particular note is the issue of high water velocities coming from the now substantially developed catchment. Observations overseas suggest that where impervious surfaces (roads, carparks, driveways, paths and rooftops) exceed 15% of the total area of the catchment, there is little opportunity for aquatic ecosystems to be sustained. This is largely the result of the enhanced quantities of stormwater from these impervious areas entering the stormwater system and typically further increasing velocities, even before the creek systems are reached. The presence and persistence of the high velocities can then destroy the aquatic ecosystems and transport organisms and damaged habitat material down the catchment. In a more natural catchment a much higher percentage of rainfall is intercepted by vegetation and is stored in the soil. While such damage to organisms and habitat will occur naturally from high intensity storms, the increased frequency of high velocities, resulting from an increasingly impervious catchment, can create an irreversible impact on ecosystem integrity.

In the case of the Manly Lagoon catchment being relatively short and steep, and with impervious areas being greater than 50% (except for the Manly Dam sub-catchment where they are currently less than 10%), this is a particularly intransigent and difficult issue. The solutions to this are limited and are only to be found in an integrated approach using water recycling and re-use, reintroduction of pervious areas and works to reduce velocities before stormwater enters the creek systems. A particular recommendation has been made for a special effort in regard to reducing the stormwater velocity in catchment.

The second meeting of the Expert Panel was held with members of the Partnership Task Group and representatives of the catchment community. This meeting focused predominately on resolving important underlying principles and assumptions so that the ICM Strategy could be consistently developed and progressed. A copy of the position paper prepared for the meeting is found in Volume 2 of this report. It contains a series of important and formative assumptions each of which was worked through and clarified by the meeting. Possibly the most important of these was the decision to address, within the ICM Strategy, dry weather flows as a priority over wet weather flows.

A most important outcome of this meeting was the decision to support principles with the Healthy Rivers Commission Statement of Intent for Coastal Waterways as the most appropriate guiding basis for the ICM Strategy. A second pivotal resolution of this meeting was that the Modified Ecosystems Management Framework (Table 3) of the Statement of Intent was supported as more appropriate for the catchment than the Targeted Repair Management Framework (Table 4) recommended by the Healthy Rivers Commission.

At the conclusion of the Joint Meeting the members of the Expert Panel were accompanied by community representatives on an inspection of the catchment. The inspection started at the outlet of the Lagoon and ended high up in the catchment. A number of sites along the Lagoon and creek-lines were inspected, as were sites



immediately above and below Manly Dam. State of the art stormwater infrastructure and community involvement projects were also inspected. Evidence of poor catchment management initiatives were noted. The inspection of the catchment provide the Expert Panel with the opportunity to view first hand the nature and extent of some of the key issues facing the catchment. The assistance and input of the community representatives with their first hand knowledge and observations was particularly appreciated by the Panel members.

On 16th June 2003, members of the Expert Panel met for the third time, again with members of the Partnership Task Group and the catchment community. The meeting considered detailed information on the State of Catchment including existing approaches and the catchment's response. There was a high degree of concurrence on most issues. Where distinct differences of expert opinion arose these were generally able to be worked through to the satisfaction of panel members. In the case of dredging in the Lagoon, the need to pursue multiple objectives assisted in acceptance of necessary compromise on specifically held views.

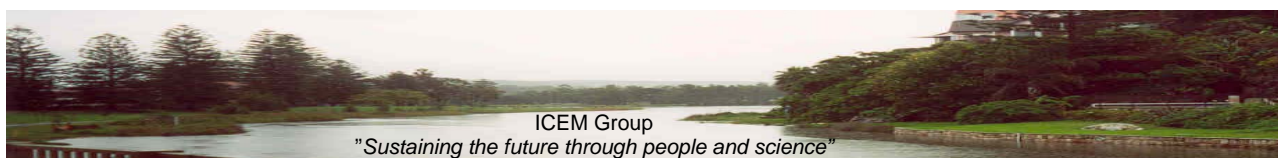
Recommendations were also considered and further developed on how the current approach could be better integrated and improved through 'state of the art' initiatives. The meeting concluded with an assessment of the degree to which the current approach and an improved integrated approach incorporating a number of state of the art initiatives, would likely achieve the catchment goals and objectives. From this evaluation an optimal strategic approach was developed for consideration by the Partnership and, if endorsed, by the catchment community. The following sections provide an overview of the deliberations and decisions of the Expert Panel.

Building Upon the Current Approach

It was the unanimous opinion of the Expert Panel that continuing with the current approach in the Manly Lagoon catchment would not achieve the catchment goals, even if each of the hundreds of activities which are currently either planned, initiated and ongoing were to be implemented. In fact, it was considered that should the current approach continue then water quality and other catchment values would most likely decline further. This is principally because the activities are not consistently pursued nor are they currently being sufficiently evaluated.

Improved evaluation is required to enable strategic targeting of the focus and level of activity as well as to determine the warranted resources in relation to the likely achievement of identified outcomes. The current lack of evaluation was considered by the Expert Panel to be a key weakness and reinforced earlier resolute deliberation regarding the absolute and urgent need to establish an overall management cycle for water quality and related issues impacting on the catchment. This management cycle should be linked to the State of Environment Reporting needs of the Councils.

The Expert Panel considered that if the currently identified activities were to be implemented within an integrated and adaptive catchment management cycle approach, then gradual progress towards the catchment goals was indeed possible. However, given natural perturbations in weather conditions and the generally slow rate of



community and institutional behavioural change, the Expert Panel considered that a period of 10 or more years would probably be required to confirm positive trends in catchment goals.

However, should significantly more effective implementation of the currently identified activities be achieved (through progressive evaluation and adaptation via a management cycle), and these activities then be supported with a small number of additional key and 'state of the art' strategic initiatives (including effectively addressing the major problems of diffuse source pollution and sewage overflows), then reasonable progress towards the goals is much more likely to happen within shorter timeframes.

It was the opinion of the Expert Panel that such progress, although quicker, would still only be gradual and have its 'ups and downs' along the way. Such progress would only be achieved by ongoing high level commitment and strong partnerships. The Expert Panel particularly noted that in order to know the nature and extent of this progress, that an appropriate planned and executed integrated monitoring framework needed to be established and given continued priority.

The Recommended Optimal Approach

The optimal approach recommended by the Expert Panel was to vigorously pursue the development and adaptive implementation of a Five Year Action Plan for the Manly Lagoon catchment. The Action Plan would capitalise on and strengthen the current partnership arrangements including the Manly Council – Sydney Water Partnership Memorandum of Understanding, the Catchment Blueprint and Stormwater Management Plan. It would also adopt a number of additional 'state of the art' activities that have been confirmed by the Expert Panel as worthwhile additional investments in the pursuit of the catchment goals and objectives.

The Five Year Action Plan would improve the consistency and effectiveness of the implementation and evaluation of the 482 yet to be completed activities identified in the current plans. This would result from the use of the Integrated Monitoring Framework informing the annual reviews of activities and outcomes. The Action Plan would also include the additional activities identified and recommended for inclusion in the Memorandum of Understanding, which is currently being revised.

The Five Year Action Plan would aim to overcome the key limitations of the current approach through:

- improved evaluation of current and planned activities;
- enhanced investment in the catchment to address priority issues of diffuse pollution, high velocity stormwater flows and sewage exfiltration, infiltration and overflows;
- advanced understanding of the causes of pollution and the decline in catchment values; and
- an improved appreciation and the development of better means to engage and galvanise community involvement and support.



After five years, through the use of the proposed Integrated Monitoring System, the Partnership would be in much clearer position to know what has been achieved and why. From this point onwards, and contrary to the current situation, strategies to improve the catchment and consequent investment decisions can be better informed and would be likely to return greater dividends. As a result, in a further 5 years optimal further progress should have been achieved towards the catchment goals, which by this stage should be within easier reach or possibly even partly attained.

The contribution of such action to biodiversity conservation and pollution control would no doubt stand the Manly Lagoon catchment in better stead. The benefits however would not be limited to the local catchment. Through the involvement of Warringah Council first hand experience and knowledge of the benefits of implementing different strategies and measuring arising responses in the catchment would be worthwhile considering for the lagoon systems and catchments immediately to the north. This would apply to many strategies but be particularly useful in areas of community behavioural change, information management and other efficiencies associated with the integrated monitoring and reporting system. Similar benefits would no doubt accrue to the rest of the Sydney Harbour Catchment through close linkages with the Blueprint and Stormwater Management planning processes.



4. Manly Lagoon State of Catchment Overview

4.1 Introduction

Manly Lagoon catchment has an area of about 18 square kilometres and is drained by Burnt Bridge Creek, Brookvale Creek and Curl Curl (Manly) Creek. The Lagoon has a surface area of about eight hectares and discharges to the Tasman Sea at Queenscliff. Elevation within the catchment varies from 160m AHD in the northwest to sea level at the ocean entrance to the lagoon. Parent rock is Hawkesbury Sandstone which weathers to fine to medium grade sand.

Land use in the catchment varies; about half is mostly developed for residential use (densities range from medium to high in the east, to low in the north and north west). A further third is open space (both developed and more natural bushland) and smaller areas are occupied by industrial and commercial developments. A dense infrastructure network (roads, sewerage, stormwater) is present. Prior to urbanisation the area surrounding the lagoon consisted of a series of low-lying wetlands that acted as retention basins during floods. With the onset of development these areas were filled and reclaimed for other uses. A large proportion of the catchment area is paved with impervious materials; these result in increased runoff and increased velocity of runoff transporting loose material into the lagoon in wet weather (DLWC 1996).

The catchment has been divided into four sub-catchment areas for convenience in preparing the State of Catchment report and as a basis for building an integrated strategy; the boundaries are as defined in the Manly Lagoon Floodplain Management Study (Department of Land and Water Conservation 1996; see Figure 2) and are described briefly in table 4a.



Table 4a

Estuary-Floodplain	Burnt Bridge	Manly Dam	Brookvale Creek
<p>Location Encompasses the areas of Manly Creek downstream of Manly Dam; Brookvale Creek, downstream from the Pittwater-Condamine junction; Burnt Bridge Creek downstream from Manly West Park ; 590 ha area (35% total catchment)</p>	<p>Location SW area of catchment; 330 ha area (18% total catchment)</p>	<p>Location NW area of catchment 510 ha area (28% total catchment)</p>	<p>Location N part of catchment (above junction of Pittwater Rd and Condamine St) 340 ha (19% total catchment)</p>
<p>Percent impervious About 50%</p>	<p>Percent impervious More than 50%</p>	<p>Percent impervious Less than 10%</p>	<p>Percent impervious 49% impervious</p>
<p>Land Use Mainly developed parkland and playing fields, playgrounds, golf courses bordering Lagoon and creeklines; residential development to N, S and W; some industrial; some commercial land (Manly CBD)</p>	<p>Land Use Predominantly urban, mainly residential; small areas of bushland and. Burnt Bridge Creek corridor is open space; other recreational areas include: Balgowlah Golf Course, tennis courts and sports fields</p>	<p>Land Use Mainly open space; Manly-Warringah War Memorial Park is 375 ha (78% bushland cover); has picnic areas, sports fields, an aquatic centre, tennis courts and the Wakehurst Golf Course (50 ha); Manly Dam (surface area ca 30 ha) provides range of recreational opportunities. Some commercial/ industrial areas and residential areas to N and NE.</p>	<p>Land Use Main land uses are industrial (Warringah Mall) residential and open space including Allenby Park (41ha of bushland); it offers unstructured recreational opportunities. Sports fields, other open space reserves comprise about 5%.</p>

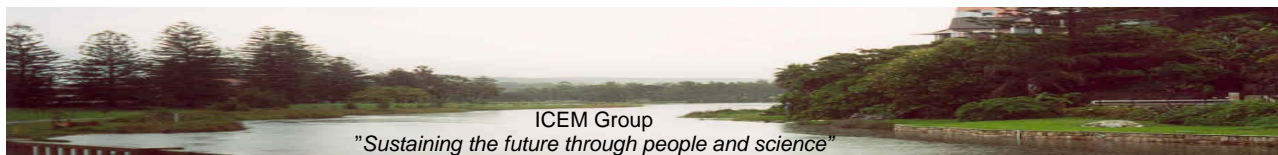
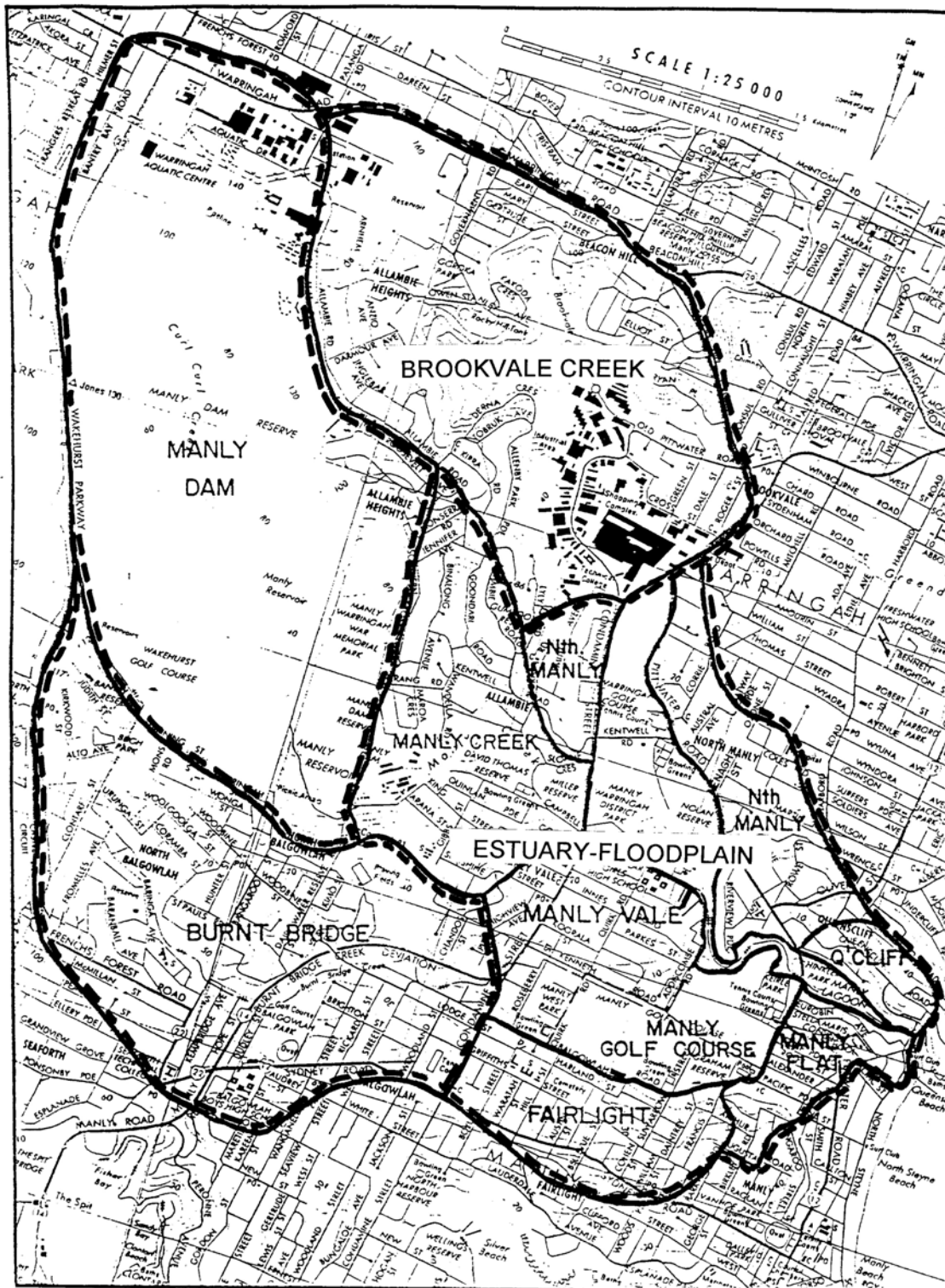


Figure 2. Manly Lagoon catchment and sub catchment boundaries



MANLY LAGOON CATCHMENT & SUBCATCHMENTS
Adapted from DLWC (1996)



Key Issues

Community values for the area have been clearly expressed and well documented at four workshops run by Macquarie University and attended by 40 community members. These values and community concerns have been taken into account in the preparation of the State of Catchment report which has confirmed the following key issues:

- **Water cycle management:** stormwater system and run-off; sewage and water use; water flow
- **Land use management:** development; contaminated land; recreation
- **Ecosystem management:** riparian corridor; aquatic ecosystems; terrestrial ecosystems

Additionally two key processes are documented: catchment health monitoring; and increasing community awareness, knowledge and involvement.

Preparation of the report

The State of Catchment report is based on a desk-top study. The process involved initial development of a bibliography of published and unpublished reports; identification of major documents for both report preparation and strategy development; documentation of community values, and concerns; and identification of key issues. Information on the current state of the key issues and the pressures on them were then summarised for each sub-catchment from the many reports available and response information collated from a further series of documents. Full catchment overviews for each issue were then prepared based on the sub-catchment analyses of the current situation and an assessment of the response activities already undertaken, continuing and planned. Data gaps were identified and also what more could be done to improve the situation. These were developed into a list of activities to be considered further by the Expert Panel and subsequently by stakeholders.

Value of the sub-catchment approach

The sheer volume of information available on the Manly Lagoon catchment made the collation and assessment of it very difficult. The sub-catchment areas drained by the three main creeks and the estuary-floodplain area differ considerably in characteristics and it was considered important that these differences were not lost through aggregation of the data. Also, it is considered that a sub-catchment approach provides a more strategic framework for decision-making and management action; a better basis for community interaction with managers; and engenders greater community interest and involvement in remedial action.

What follows is a State of Catchment overview. Available in Volume 2 of this Report is a more detailed outline of the methods used in compiling the State of Catchment report, further discussion of the value of the sub-catchment approach, summaries of the information collated on each key issue, a list of the references used and a bibliography.



4.2 State of Catchment Overview

The information presented below outlines very briefly the current situation and the responses in place or planned for each key issue. A summary of status and expected future trends then links directly with the proposed ICM Strategy goals.

Water Cycle Management

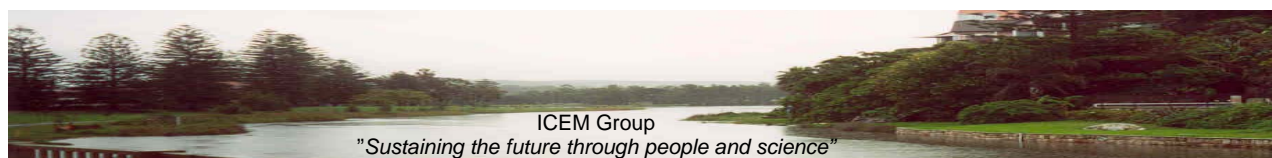
Current Situation

Stormwater: The catchment has high percentage of impervious surfaces so stormwater run-off quantities are great and velocities are high; the only area where this is not true is in the Manly Dam catchment where less than 10% of the area is impervious. Stormwater is currently not used as a resource but rather is collected in a highly connected system and discharged directly into drainage lines and watercourses or into natural bushland. While there are many stormwater control devices in place in some cases their design is inadequate and efficacy questionable; maintenance costs are generally high. There is little space available for artificial wetlands and where they are present they are often too small and require regular management.

Sewage: The majority of the catchment is sewered; the only unsewered areas are located in the bushland reserves of Manly Dam and Brookvale Creek sub-catchments. Stormwater infiltration occurs in wet weather and sewage exfiltration occurs when there are system breakdowns. While Sydney Water has already repaired sewerage lines in some parts of the catchment other areas are still being investigated (staged process). Numerous overflow events still occur throughout parts of the catchment, often these occur directly within streams or along streambanks. Overflows are known to occur during even moderate rainfall (up to 10mm) and some overflow points have average discharge frequencies of up to 200 events in 10 years. This situation is exacerbated further by passage and influence of major sewerage trunk drainage mains serving large populations outside of the catchment. These large mains also have potential to overflow into the lagoon. A large problem also remains with the private sections of the sewerage system which needs to be checked ('pipe check' program) and where necessary repaired; both the 'pipe check' and repairs are expensive.

Water Use: Potable water consumption per person per year is estimated at 126 kl and 121 kl for Manly and Warringah LGAs respectively; this is slightly below the Sydney average of 129 kl per person per year. Potable water is used for many household and property tasks, and also by industry when non-potable sources would be adequate. There is currently little re-cycling or re-use of water.

Water Flow: Manly Lagoon is a relatively small and shallow coastal estuary; its capacity to hold water during rain and flooding events is quite low. Open Space areas in the lower reaches of the creeks and Lagoon act as floodways during high flows and low lying areas flood naturally. Low flow pipes allow circulation of ocean water into the Lagoon and since the low flow pipes have been extended there is improved tidal circulation and exchange at the ocean end of the Lagoon in dry weather. The whole Lagoon hydrology is highly altered by stormwater flows. The Lagoon is surrounded by



urbanised lands and two of the three main sub-catchment creeks are also largely urbanised with impervious surfaces ca 50% or greater than 50%. Creek channels are highly modified over their lower reaches; they carry high quantities (and velocities) of runoff in wet weather. These increased flows and sedimentation have increased the potential for localised flooding in the lower parts of the catchment. Catchment runoff and ocean tailwater can independently and jointly control the flood conditions in the Lagoon; entrance opening procedures are critical to Lagoon flood behaviour. Manly Dam has a storage capacity of ca 2000ML and water levels are controlled by three scour valves to maintain 1.7m of flood storage space. Storage levels in Manly Dam could affect flood levels in the Lagoon.

Impacts

Stormwater pollutants include toxic substances that have the potential to adversely affect human health and these, together with high sediment, nutrients and gross pollutant loads impact on aquatic and terrestrial biota and habitats over a considerable period of time. High velocities of stormwater damage to watercourse channel beds and banks also adversely impact on ecosystems. Stormwater pollution reduces amenity and scenic quality.

Sewage overflows have adverse impacts on aquatic and terrestrial ecosystems and the potential to adversely affect human health.

Manly Dam disrupts the natural flow regime and is a barrier to fish and other aquatic organisms; stratification and high nutrients in water can lead to algal blooms. Dry weather flows downstream of the Balgowlah Golf Course (Burnt Bridge Creek) are decreased due to abstraction by the Golf Club and storage of flow behind a weir within the creek channel which additionally acts to dissipate flows, particularly in dry seasons

Flooding has in the past caused considerable loss of property and damage to homes on the floodplain. Some 38 commercial, industrial and public premises, and 77 residential buildings are flooded above floor level in the 1 % AEP (Annual Exceedance Probability) flood.

Responses

A large number of activities have been, and are being undertaken to address water quality issues with the major focus being on stormwater management. These and other projects cover identification of pollution sources, education about pollution linked to assessment and enforcement activities, direct management of industrial pollution and intervention to stormwater flows and education about improved household and property management practices. In addition there are improved development application approval processes in place and the requirement for on-site erosion and sediment controls and water management.

Some remediation of the sewerage system has occurred and water conservation is being promoted throughout the catchment. Dredging of parts of the Lagoon is planned to reduce the flooding potential, improve tidal circulation and assist in rehabilitation of aquatic habitats. Improvements in tidal exchange at the Lagoon entrance have already



been made and also changes to the management of the Lagoon entrance to ensure floods have reduced impact on surrounding developed areas.

Land Use Management

Current Situation

Land Development: Generally there is only limited development potential within the catchment but some localised medium to high density development is occurring and some subdivision potential exists; re-development of older sites is also occurring. Currently impervious surfaces amount to ca. 50% or more than 50% in the Estuary-Floodplain, Brookvale Creek and Burnt Bridge Creek sub-catchments but are less than 10% in Manly Dam sub-catchment and there is an identified need to protect this subcatchment from further development. A range of planning and management controls are in place to minimise and address adverse impacts of development. However, opportunity does exist for better ameliorate impacts both generally, and more specifically on environmentally sensitive lands, during redevelopment which could actively pursue a policy of nil net export of pollutants.

Contaminated land: Many parts of the original Lagoon margins and floodplain have been reclaimed by filling with dredged lagoon sediments and other sites have been former garbage tips and landfill sites. Former landfill-waste disposal sites also occur in the northern corner of Manly Dam sub-catchment and a former gas works site adjoins the Burnt Bridge Creek Deviation in that sub-catchment.

Recreation: The estuary and Lagoon floodplain provide a range of areas for active recreation (playing fields, playgrounds) and more passive recreation (picnic areas) and there are many other playing fields and small developed parks throughout the catchment. Three golf courses are present: Manly and Warringah on the floodplain and Balgowlah bordering Burnt Bridge Creek. Extensive bushland reserves are present: Manly-Warringah War Memorial Park covers some 375 hectares (78% is bushland) and Allenby Park is 41 ha in area. Current uses of the Lagoon and its foreshores include fishing (catch & release only), walking, bicycling, picnicking and general observation; previously also used for swimming and boating. Burnt Bridge Creek has a bicycle and walking track of some length; Manly Memorial Park provides a wide range of active and passive recreational activities on both land and water; Allenby Park is used mainly for bushwalking and picnicking.

Impacts

Leachate from contaminated sites includes heavy metals, PAHs and other toxic substances. Dumping of green waste is a major issue along Burnt Bridge Creek and illegal dumping of various materials occurs sporadically throughout the catchment

Developed open space contributes to pollution (litter and fertiliser) especially if maintenance practices are ineffective; high nutrient run-off; sediments from eroded tracks, toxic pollutants from herbicide and pesticide use all impact adversely on terrestrial and aquatic ecosystems. Golf courses extract water and reduce natural flows.



Responses

Considerable effort has been expended on improving policies and planning instruments relating to land development and land use over the last few years to minimise adverse impacts. Maintenance of environmental integrity and protection of environmentally sensitive areas are promoted and broad community education programs are in place to increase awareness of land degradation issues and how they can be addressed. The major bushland reserves have management plans being implemented, Councils' on-ground management practices for water and chemical use on playing fields and developed parks have been audited and reviewed and liaison with golf course managers is ongoing.

Ecosystem Management

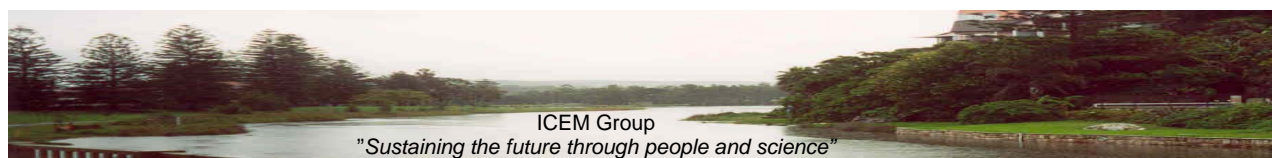
Current Situation

Riparian Corridor: The condition of riparian corridors varies throughout the catchment. The most natural creek is Curl Curl in the upper Manly Dam subcatchment; it is considered to have very high ecological value (Group A in the Warringah Council Creek Management Strategy) and is recommended for protection. The upper reaches of Brookvale Creek in Allenby Park are also in a natural or near-natural state although surrounded by residential and industrial development. Burnt Bridge Creek and the creeklines in the Estuary-Floodplain subcatchment (lower parts of Brookvale and Burnt Bridge Creeks and Manly Creek) are highly modified. In these areas: channel profiles have been modified or destroyed; sediments have been deposited in various places and at some sites regular maintenance dredging is undertaken; fine sediments (silts, muds) are contaminated with heavy metals, PAHs, etc. - some at levels higher than ANZECC guidelines; natural flows are disrupted by artificial structures and by weed chokes; and creek banks are unstable, highly eroded or gullied and weed infested, or artificial.

Aquatic ecosystems: Aquatic ecosystems are mainly natural or near-natural with a range of habitat features in upper reaches of Curl Curl, Brookvale and Burnt Bridge Creeks; ecological values high (Curl Curl) to moderate. Lower reaches of Burnt Bridge, Brookvale and Manly Creeks all highly modified, channelised or armoured in parts with few habitat features; ecological values are low. Level of connectivity between floodplain and riparian zone varies from high (Curl Curl) to moderate (Brookvale Creek - Allenby Park), to low (Burnt Bridge Creek - encroachments). There are localised infestations of *Ludwigia* and other aquatic weeds and riparian weeds are extensive, often dominant. A variety of fish are present in the Lagoon and a rare fish species has been recorded in Curl Curl Creek. The macrophytes present in Burnt Bridge Creek are dominated by exotic species (7 native species compared with 13 exotics) and their presence and abundance elsewhere is not recorded. Macro-invertebrate diversity is relatively poor (also some exotics present) reflecting poor water quality and other adverse impacts.

Terrestrial ecosystems

Two sub-catchments (Manly Dam and Brookvale Creek) have some large areas of native vegetation in reserves and some vegetation types of high conservation value (coachwood and forest oak forests), and others that are rare (laterite forest, sandstone



swamp communities). Burnt Bridge Creek sub-catchment has some remnant riparian vegetation (including gully forest and wet and dry sclerophyll forest), and the Lagoon estuary-floodplain has some isolated pockets of vegetation and native trees within parks; elsewhere deciduous exotic species are abundant. Reedbanks occur along parts of the Lagoon margins. Weed infestations are severe in some parts of the catchment (lower parts of Burnt Bridge Creek) and elsewhere are more localised. There is a diversity of native animal species (reptiles, amphibians, birds) in the extensive bushland reserves but elsewhere mainly those species well adapted to urban environments.

Impacts

The riparian corridor and other aquatic and terrestrial ecosystems are adversely impacted upon by the different land and water uses discussed above.

Responses

Major projects over the last few years involving Councils and the community have focused on rehabilitation of the riparian corridors of Burnt Bridge Creek and the estuary-floodplain section of Brookvale Creek. The work continues and these areas are now improving. Extensive information, education and training programs are in place relating to weed control, bush regeneration and bushland management and there are many community groups working actively on these aspects throughout the catchment. Local provenance species are used in all reserves and streetscapes and are widely promoted for use in landscaping and gardens. Improvements to the Lagoon and tributary creek wetlands are also a focus for community action and a number of programs such as Streamwatch, Frogwatch and Coastcare combine education with field activities.

Responsible property and domestic animal management are both widely promoted with guidelines and other useful information available. Pest control is undertaken regularly in Manly Dam subcatchment.

Key Processes

Catchment health assessment and monitoring

Water quality monitoring, mainly of the biophysical variables, has been carried out over a number of years at Lagoon sites and also at Manly Dam; more recently sampling of sites within Burnt Bridge creek and Brookvale Creek have been undertaken. Some macroinvertebrate studies have provided useful information and a number of tertiary student research projects (carried out over last 3 years by UTS) on water quality, sediment quality, biodiversity and ecology in various parts of the catchment have provided valuable snap-shot and baseline information.

A number of vegetation and biodiversity assessments have been undertaken for riparian and remnant bushland areas to assist with development of management plans. Audits of Council on-ground operations and of various industry practices are carried out regularly and linked with educational programs.



Increasing community awareness, knowledge and involvement

A recent survey of catchment residents indicates a relatively high awareness of environmental issues, a good understanding of pollution issues and a high level of involvement in recycling and water conservation practices. Community-based environmental activities have a high profile in the catchment and are well supported by Manly and Warringah Councils.

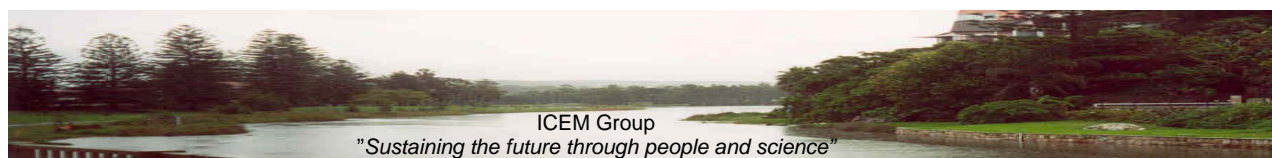
Councils distribute a broad range of information and educational materials to assist the community to increase its knowledge and understanding of natural resource and environmental issues. They provide practical suggestions on how to address issues at the property, local and more regional scale and have a number of innovative projects underway.

4.3 Indicative status and trends

The sub-catchment analyses allow the development of an 'indicative status' for key issues for the Manly Lagoon catchment as a whole. The data available does not permit trend analysis but consideration of the types of management responses currently underway and planned allows for expected trends over the next few years to be outlined. The current status and future trend information are linked directly to the Integrated Catchment Management Strategy in the following tables.

Goal 1: Water quality, velocities of flows, and waterway features which protect ecosystems and sustain community desired values for public health and recreation.

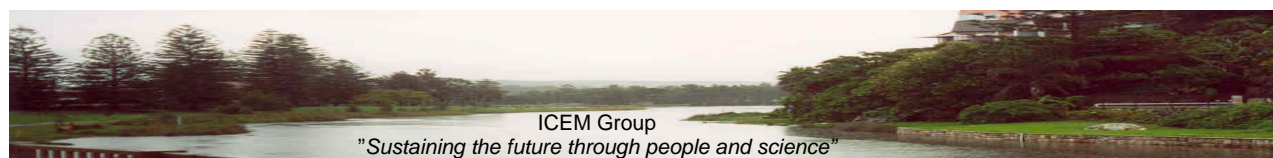
Aspect	Current status	Future trend (over 5 years)
Water quality	Poor	Some improvement as management responses take effect; no deterioration overall
Tidal exchange	Good at Lagoon entrance and in lower estuary	Some improvement with sediment removal; exchange further up waterway
Sediment contamination	High levels in uppermost sediments	Some improvement with sediment removal but potential for mobilisation of contaminants over many years
Dry weather flows	Poor - impeded in places; surface water abstraction in places	Could be further reduced if increased abstraction by golf courses is permitted.
Wet weather flows	High - stormwater discharges erosive due to impervious surfaces, connectivity of system, part channelisation of creeklines	Improvements (reduction in velocity) as management responses take effect
Flooding	Entrance regulated; dredging works and opening of culvert and island should decrease bottleneck and reduce flooding.	Little change



Pollution loads (wet weather)	High – stormwater, sewerage overflows, gross litter, sediments, nutrients, organics, heavy metals and other toxic substances	Improvements (reduction in pollutant loads) due to management responses - regular maintenance of GPTs, improved on-ground practices, 'treatment train approach', education.
Riparian corridor and Aquatic ecosystems: ➤ Species diversity ➤ Habitat diversity	Fragmented, natural to strongly modified Variable - upper creeklines natural or near natural, lower modified; some barriers to fish Variable - lower catchment areas depauperate Variable - natural areas diverse, modified areas ecologically poor	Improvements to banks and vegetation cover; little change to channel form; little change to species and habitats

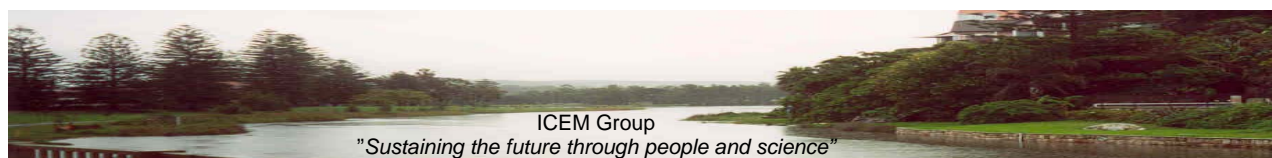
Goal 2. Open space, natural landscape features and waterways can support on-going high quality passive and active recreation and related community education.

Aspect	Current status	Future trend (over 5 years)
Developed open space: ➤ Golf courses ➤ Playing fields ➤ Parks	Well-used to overused for active recreation High nutrient & chemical use (fertilizer, pesticides, herbicides) for maintenance High water use - abstraction of surface & ground water Dominated by exotic trees, grasses; poor quality habitat High impacts on native ecosystems	Continue to impact adversely on native ecosystems unless management improved (water use, fertiliser & chemical use strictly controlled)
Natural bushland/open space reserves	Large reserves with high biodiversity conservation and ecological values; scenic quality and heritage values Well-used for both passive and active recreation	Degradation variable - sensitive areas will degrade relatively fast unless protected and; other areas more slowly unless use of reserves actively managed
Waterways ➤ Manly Dam ➤ Lagoon	Well-used to over used Water quality generally moderate with some algal blooms; some controls on use Margins well-used but swimming, boating and fishing not permitted.	Degradation if over-use not controlled Some water quality improvements as pollution control becomes effective
Educational use	Streamwatch and other educational projects using resources; Manly Dam SC and entire catchment to some extent used by tertiary students for biological research projects	Somewhat increased use as educational resource for all community sectors providing useful assessment and monitoring information (dependent on technical and financial support)



Goal 3. Natural resources are managed and conserved to enhance and sustain desired biodiversity, heritage and other catchment values.

Aspect	Current status	Future trend (over 5 years)
Sensitive landscapes/areas	Environmentally sensitive areas (wetlands, riparian corridors) and those with land use constraints (acid sulfate soils, land slip areas) protected in planning instruments (or will be through revision of LEP by Warringah Shire Council). Assessment of impacts required in DA process	Improved protection and knowledge of relevant sites by Council and community
Natural habitats ➤ Along waterways ➤ Elsewhere in catchment	Mainly fragmented (see Goals 1, 2) Major continuing efforts with revegetation and management of repaired sites throughout catchment	Improvement of both aquatic and terrestrial habitats with continued community efforts supported by Councils
Introduced species ➤ Plants ➤ Animals	Exotic species dominant in some areas; elsewhere localised. Noxious weeds on private land managed through legislation; other weeds through Council-community efforts. Feral animals regularly controlled in reserves Responsible management of pets encouraged through education	Improvements in high conservation value areas and elsewhere as specific management plans prepared and/or implemented Little change to feral animal populations unless further resources allocated Less impact on biodiversity through improved control of pets.
➤ Streetscapes & developed areas (residential, commercial, industrial, etc.)	Currently mixture of exotics and native trees & shrubs. Use of local provenance native species in landscaping and on private properties encouraged through education; already used on public lands.	Increasing percentage of native species in developed areas and some development of corridors linking larger bushland remnants
➤ Cultural values & heritage sites	Aboriginal and historic European heritage sites listed and protected through legislation	Improved awareness of heritage and cultural values through education and involvement in management

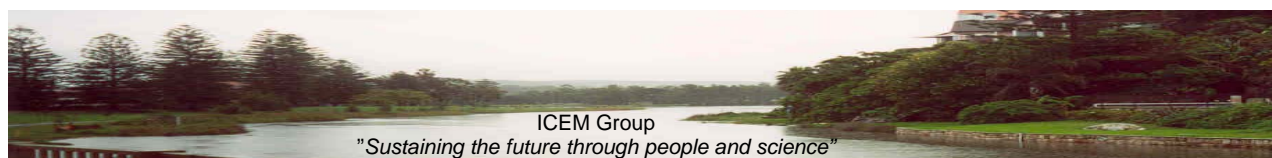


Goal 4: To enhance the pursuit of the Goals 1,2 and 3 through ongoing 'state of the art' integrated and adaptive management of the catchment and its resources

Aspect	Current status	Future trend (over 5 years)
Integration in management approach ➤ Council-Agency ➤ Council - Community ➤ Agency-Community ➤ Council-Agency-Community	Some partnerships in place but more formal process needed to improve effectiveness; or champions/leaders needed to generate action Working effectively on bushland rehabilitation, Streamwatch, Coastcare, etc.	Little change unless increased political will to act and greater responsibility assigned to partnerships agreements Continue to improve with continued technical & financial support
Community awareness & knowledge	Equal or somewhat higher than NSW average; specific community groups highly knowledgeable	Improve with continuing broad & specific educational programs
Community involvement ➤ Decision-making ➤ On-ground improvements ➤ Management	Some involvement in committees Very active (see above) Some involvement in reserve management	Little change unless Councils actively seek more involvement and assign greater responsibility to community
Information acquisition ➤ Assessment/surveys ➤ Access/sharing of information	Variable quantity; quality high Some useful surveys of riparian corridors, bushland reserves, creeks, biota Much unpublished, not readily available; MEC valuable resource centre	Little change unless further resources allocated
Monitoring	Mainly water quality, little on flow, little regular monitoring of biodiversity, social aspects (recreational use) Community-based monitoring valuable	Strategic water quality monitoring developed if planned reviews undertaken Increased community monitoring if resources allocated
Integration of reporting systems	Some integration through joint agency-council committees and feedback to community on specific projects	Little change

Reference cited

Department of Land & Water Conservation (1996) *Manly Lagoon Floodplain Management Study*- prepared for Manly & Warringah Councils.



5. The Manly Lagoon ICM Strategy

5.1 The Origin and Role of the ICM Strategy

The Manly Lagoon ICM Strategy has been developed under the direction of the Sydney Water Corporation and Manly Council Partnership (the Partnership). The ICM Strategy takes the community endorsed values already established for the catchment and develops a means to better protect these. It does this by providing a strategic framework and a management process which works progressively towards achieving long term goals by achieving specific measurable outcomes along the way. A vital component of the ICM Strategy for Manly Lagoon and Catchment is the proposed integrated monitoring and reporting system. This component not only verifies the nature and extent of progress but also aims to openly and simply convey this to the catchment community.

The ICM Strategy has been developed within the philosophy and context provided by the NSW State Policy on Total Catchment Management or TCM as it is widely known throughout NSW. While TCM is the state wide adopted term in NSW, the term Integrated Catchment Management or ICM is used more commonly throughout Australia and overseas. So what is TCM/ICM and how can it help sustainability in the Manly Lagoon catchment?

TCM is defined in the Catchment Management Act (1989) as the “co-ordinated and sustainable use and management of land, water, vegetation and other natural resources on a water catchment basis so as to balance resource utilisation and conservation”. The Review of TCM in NSW during the mid 1990’s put forward the following characteristics as being recognised ICM international best practice. At that time, and to many still involved with catchment management, these characteristics are believed to be central to effective land and water resource management on a catchment scale. The desired features are: consistent commitment; clear investment framework; contracts for action; community participation; iterative project cycle; cost sharing partnerships; co-ordinated team approach and monitoring and evaluation.

More recently Born and Genslow (2001) recognised the dramatic international expansion of collaborative catchment (watershed) partnership initiatives. Although individual key characteristics are not new, the integrated approach to address complex water and related natural resource management issues is new. The key characteristics now recognised internationally for ICM include:

- Use of the water catchment as the basic planning and management unit;
- Address a broad scope of issues;
- Exhibit a systems orientation and incorporate multiple means;
- Goals pertain to healthy ecosystems, economic returns and natural resource management;



- Include interactions among multiple agencies and multiple levels of government and local knowledge;
- Involve influential and voluntary participation of many local and non-governmental interests; and
- Features collaborative problem-solving, planning and management considerations.

This ICM Strategy for Manly Lagoon catchment embraces the above characteristics of recognised best practice so that they can be used to inform and review the management and co-ordination processes from time to time. More specifically, it has been also been guided by the principles within the NSW Government endorsed Statement of Intent for Coastal Lagoons. These principles are presented in Table 5a on the following page and largely embrace the key characteristics of ICM. They include key principles of continuous improvement, inclusiveness, adaptive management and partnerships. The Healthy Rivers Commission Statement of Intent, along with the above key characteristics of ICM, are considered pivotal to the future success of the Strategy and all its activities.

It is strongly recommended that the adopted ICM Strategy for Manly Lagoon follow the above characteristics and principles. By drawing upon the ICM characteristics and Statement of Intent principles, the ICM Strategy can become firmly grounded within a Community-Government partnership approach. This allows the community endorsed catchment values to be pursued through integrated and adaptive co-operative management and influential participation of all parties.

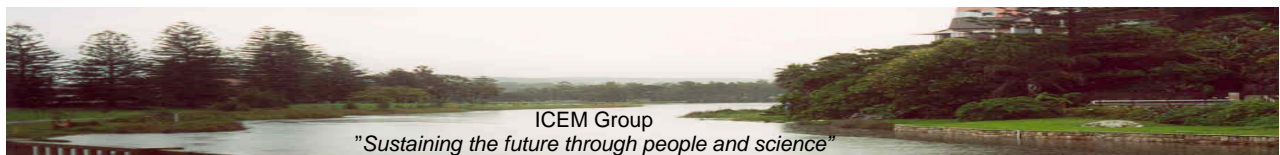


Table 5a Manly Lagoon and Catchment ICM Strategy Principles

(From Statement of Intent - Coastal Lakes – Healthy Rivers Commission)

Each coastal lake and its catchment is to be managed as a whole system.

Coastal lakes and their catchments are to be treated as assets with productive values to be sustained by carefully directed management.

Decisions about coastal lakes must be governed by realistic assessments of their capabilities and recognition of their limitations.

Management actions are to address the unique characteristics and interrelationships of ecosystems and human activities for each coastal lake, taking account of the degree of existing modification and the conditions sought.

Management actions for coastal lakes must provide for further adaptation in light of the inherent scientific uncertainties and limited information bases.

Management plans are to be sufficiently clear to create explicit obligations on the responsible public authorities with powers and resources that can be applied to coastal lake management.

The responsibilities of public authorities and communities are to be clearly stated and outcomes achieved through partnership arrangements.

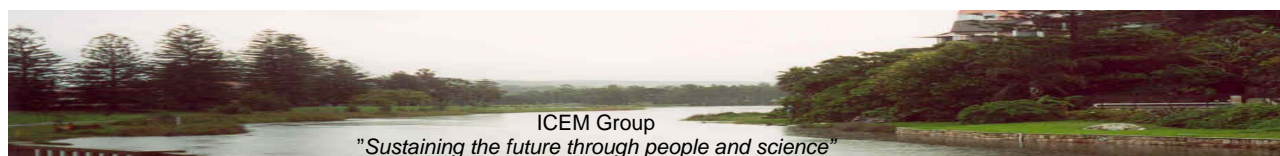
The responsible public authorities are to be accountable for the condition of coastal lakes at the conclusion of each cycle of planning, action and assessment.

They are to be accountable for the proper implementation of agreed management processes where actual outcomes are subject to a variety of uncontrollable external influences.

The ICM Strategy provides a strategic framework to co-ordinate and guide the many community and government activities that impact on the health of the Lagoon and its catchment. It has been developed upon a strong foundation of local experience and knowledge as it has drawn upon all major government plans and strategies relating to the area. The Strategy has been strengthened by the further involvement of agency and local government members of the Partnership, community representatives and members of an Expert Panel formed to assist with its development.

The plans and initiatives which have principally shaped the Strategy, and from which 482 existing current activities have been principally drawn, include:

- Statement of Intent for Coastal Lakes,
- The Sydney Harbour Catchment Blueprint,
- Warringah and Manly Council's Blueprint Local Implementation Plans,
- Stormwater Management Plan,
- The Estuary Management Plan,
- Floodplain Management Plan,



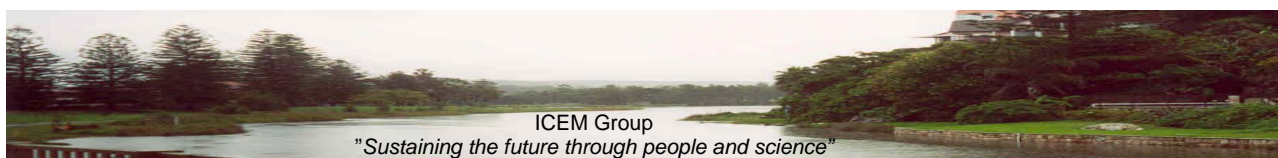
- Burnt Bridge Creek Plan of Management,
- Allenby Park Plan of Management,
- Manly Council Sustainability Strategy,
- Warringah Council Creek Study.

The Strategy is an enabling document which, when adopted after community consideration, should be used by the Partnership Committee in a continuous process of implementation and adaptive review. Effectively implemented through ongoing influential participation of the key stakeholders (including the catchment community) it should result in progressive improvements in communication, co-ordination, co-operation and consistency in the planning, implementation and review of activities; particularly those activities which relate to the pursuit of the sustainable use and management of the catchment's natural resources.

The Strategy identifies what has been done and what is planned, initiated or ongoing. However it goes further to identify and list additional activities that should be done. Recommendations are also provided to effect better co-ordination and integration of the current activities and to improve efficiencies and effectiveness in terms of costs and strategic outcomes. These recommendations are presented in Chapter 2 of this report.

The Strategy provides a clear direction for management. It has been developed over the past 12 months by an independent team led by the Integrated Catchment and Environmental Management Research Group from the University of Western Sydney. It is now at a stage that, once the community have had an opportunity to comment and appropriate adjustments are made, it can be immediately picked up and progressed. By outlining how the community's and government's desire for a future healthy catchment and waterways can be significantly progressed, the Strategy is ready for implementation and progressive review. The Strategy confirms the community desired long term goals, identifies realistic interim (5 year) objectives, the means to achieve these objectives and suggestions on how progress might be best measured and transparently communicated.

The goals of the Strategy are those previously endorsed by the catchment community and principally relate to their well documented values for water quality. However, as the eight objectives and twenty-two sub-strategies stem from the above existing plans they cover a wide range of issues and matters. The completed strategic framework shown following in Table 5c, while still consistent with the above-mentioned plans, has been shaped and melded to act as an integrated and mutually supportive framework for planning and action. The ICM Strategy is directly informed by the State of the Catchment analysis (see Chapter 4) and a review of existing and planned State and Local Government activities impacting on the catchment and its waterways (See Chapter 3). Accordingly, the Strategy is as up-to-date as possible and both widely and directly informed by an in depth desk top analysis.



The development of the ICM Strategy has capitalised on the considerable quantities of information and data already available on the catchment. An improved understanding of the catchment processes and issues has been developed and is outlined in Chapter 4 – The State of the Catchment. This has resulted in development of ‘real world’ solutions that consolidate, adapt and supplement current and planned approaches. By investigating and developing directions and practical solutions within a ‘big picture framework’ and in close co-operation with the member organisations of the Partnership (most of whom hold many key responsibilities for implementation) there has been a noticeable improvement in the level of understanding and ownership of the issues and solutions.

5.2 The catchment vision and goals

The vision for the catchment focuses primarily on the production of improved water quality as an integrating outcome reflecting sustainability. It is:

“Water quality in Manly Lagoon and feeder streams that sustains the natural ecosystem and support public health in swimming and recreation”.

Consistent with this vision, four long term goals have been developed. Three of the goals relate to the catchment’s needs for sustainability and the communities’ values. The fourth goal seeks to better ensure that these needs and values are respectively met and sustained through continuing and highest quality approaches to integrated and adaptive catchment management.

The long term goals for Manly Lagoon catchment are:

Goal 1

Water quality, velocities and flows, and waterway features that protect ecosystems and sustain community desired values for public health and recreation.

Goal 2

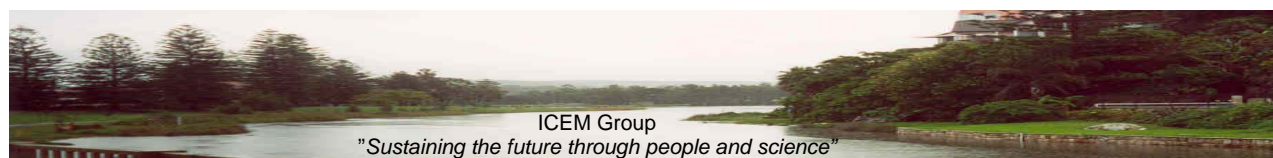
Open space, natural landscape features and waterways can support on-going high quality passive and active recreation and related community education.

Goal 3

Natural resources are managed and conserved to enhance and sustain desired biodiversity, heritage and other catchment values.

Goal 4

To enhance the pursuit of the Goals 1,2 and 3 through ongoing ‘state of the art’ integrated and adaptive management of the catchment and its resources.



5.3 The Objectives

An integrated set of objectives has been developed to provide medium term (5 year) direction to the Strategy while still maintaining a good level of consistency with existing strategies and plans. These objectives each represent a progressive step towards the achievement of the long term goal to which they relate. As all the goals and objectives are mutually supportive achieving one objective assists other goals and objectives as well.

There are three objectives relating to Goal 1, Water Quality. These are objectives 1, 2 and 3 of the Strategy and focus on improving urban run-off and creek water quality, the lagoon and its feeder creeks.

Objective 1

To improve and then maintain the quality of water entering Manly Lagoon by improvements to sewerage infrastructure, urban runoff and creeks.

Objective 2

To maintain and enhance the waterway features, flows and tidal interchange of the Lagoon.

Objective 3

To maintain and enhance the waterway features of the creek corridors and channels and return these to a more natural state.

There is one objective relating to Goal 2, Open Space, which is Objective 4 of the Strategy and aims to protect values and manage natural settings and open space in the catchment.

Objective 4

To protect catchment values and manage natural settings and open space to facilitate appropriate recreation and tourism and act as an educational resource.

Goal 3, Conservation has four principally supporting objectives which aim to improve pest and weed control, native vegetation management, cultural heritage management and habitat conservation. Together these constitute Objectives 5,6,7 and 8 of the Strategy.

Objective 5

To manage and control, where practicable and beneficial, introduced species having adverse impact on native flora and fauna and catchment values.

Objective 6

To maintain, and rehabilitate where practicable, natural habitats along waterways and throughout the catchment.



Objective 7

To manage and enhance native vegetation environment to ensure viability.

Objective 8

To acknowledge and protect Australian cultural values and heritage sites.

Finally Goal 4, Integrated Management has one objective, which is Objective 9 of the Strategy and aims to ensure the most appropriate approach is used to manage catchment impacts.

Objective 9

To adopt an integrated and adaptive approach to the management, human use and arising impacts on the values of natural and built resources.

5.4 The Strategies

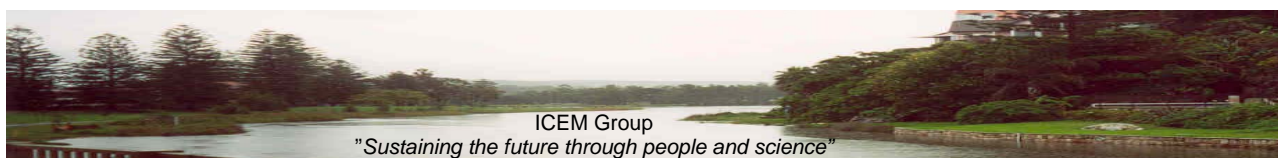
To facilitate the achievement of each of the nine objectives a number of sub-strategies have been developed from existing plans but strengthened where required to better ensure real outcomes through a more consistent and integrated approach. In all, there are 22 strategies which together provide the strategic direction on how each of the 482 activities in the ICM Strategy should be undertaken. Table 5c shows the relationship between the catchment goals, objectives and sub-strategies.

Table 5c Goals, Objectives and Strategies of the Manly Lagoon ICM Strategy

Goal	Objective	Strategies
<i>Goal 1: Water quality, velocities and flows, and waterway features which protect ecosystems and sustain community desired values for public health and recreation.</i>	Objective 1. To improve and then maintain the quality of water entering Manly Lagoon by long term improvements in urban runoff and creeks.	1. More clearly identify sources of pollution. 2. Increase resource commitment to enforcement and assessment activities. 3. Increase water conservation and water re-use practices to reduce runoff and stormwater flows. 4. Reduce erosion and suspended sediment loads within waterways. 5. Reduce urban and industrial pollutants including green waste, oils and nutrients in stormwater runoff. 6. Reduce sewer overflows, infiltration and exfiltration from sewerage
	Objective 2. To maintain and enhance waterway features, flows and tidal interchange of the Lagoon	7. Improve tidal exchange and water flows within the lagoon. 8. Address issues of water quality and flooding in the lagoon.



	Objective 3. To maintain and enhance waterway features and return creek corridors and channels to a more natural state. *	9. Restore environmental flows where possible. 10. Restore, to the extent practicable, creek channels to a more natural state in terms of channel form, bank stability, habitat features and pollution assimilation capability (include existing concrete lined drains).
<i>Goal 2. Open space, natural landscape features and waterways can support on-going high quality passive and active recreation and related community education.</i>	Objective 4. To protect catchment values and manage natural settings and open space to facilitate appropriate recreation and tourism and act as an educational resource.	11. Mitigate adverse impacts of stormwater on all remnant bushland areas. 12. Minimise adverse impacts of stormwater management facilities on public safety. 13. Improve access and provide facilities to enable appropriate recreational pursuits and educational use.
<i>Goal 3. Natural resources are managed and conserved to enhance and sustain desired biodiversity, heritage and other catchment values.</i>	Objective 5. To manage and control, where practicable and beneficial, introduced species having adverse impact on native flora and fauna and catchment values.	14. Control weed sources and feral animals in riparian corridors and the catchment generally.
	Objective 6. To maintain, and rehabilitate where practicable, natural habitats along waterways and throughout the catchment.	15. Manage and rehabilitate bushland habitats, building corridors between remnants. 16. Maintain and enhance riparian corridors, and other freshwater and estuarine ecosystems.
	Objective 7. To Manage and enhance native vegetation environment to ensure viability.	17. Adopt landuse and environmental planning measures and practices to minimise adverse impacts on native animals and vegetation, particularly within urban areas.
	Objective 8. To Acknowledge and protect Australian cultural values and heritage sites.	18. Involve Aboriginal community in management and conservation of cultural assets. 19. Educate the community on the need to value, protect and support cultural values and heritage features.
<i>Goal 4: To enhance the pursuit of the Goals 1,2 and 3 through ongoing 'state of the art' integrated and adaptive management of the catchment and its resources.</i>	Objective 9. To adopt an integrated and adaptive approach to the management, human use and arising impacts on the values of natural and built resources.	20. Continue broad based public education and community and industry support in catchment management. 21. Pursue and support integrated approaches to catchment management. 22. Develop and implement integrated monitoring frameworks for all aspects of catchment management



5.5 Long Term and Medium Term Outcomes and Performance Indicators

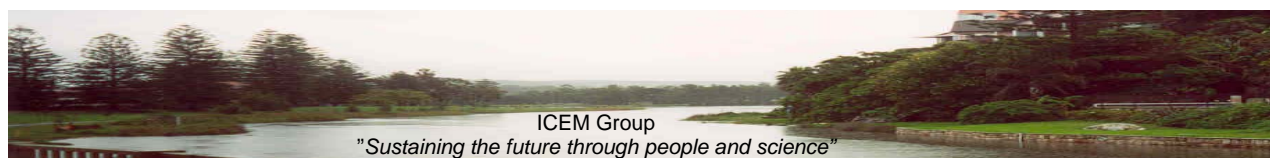
To assist with the process of the management and regular review of the ICM Strategy, a series of Outcome Statements has been developed for each long term goal and medium term objective. Table 5d shows the long term outcomes and medium term outcomes that the ICM Strategy aims to facilitate. Each outcome statement has an initially recommended performance indicator that can assist clearer determination of progress and help those responsible for co-ordinating and implementing the various activities have a clearer idea of what is required.

Table 5d Outcomes and performance measures for Manly Lagoon ICM Strategy

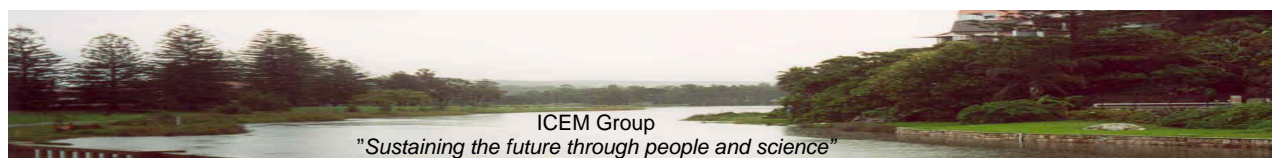
Goals and Objectives	Long term and Five Year Outcomes (Environmental, Social, Economic)	Performance Measures/Indicators
<i>Goal 1: Water quality, velocities and flows, and waterway features which protect ecosystems and sustain community desired values for public health and recreation.</i>	Healthy aquatic and terrestrial ecosystems are sustained. In any ten year period, there is an average of two events per year when swimming is not recommended in the lagoon for 3-4 days after rain because of human health reasons. Enhanced and consistent application of environmental planning and regulatory instruments, education and incentives throughout the catchment.	% of time when water quality meets water quality objectives at key monitoring sites. (Water quality Monitoring) Number of events that water quality in Manly Lagoon does not meet objectives for primary recreation. (Water quality Monitoring) Assessment of the application of environmental planning and regulatory instruments, education and incentives (Stakeholder evaluation)
Objective 1. To improve and then maintain the quality of water entering Manly Lagoon by long term improvements in urban runoff and creeks.	Reduced pollutants entering waterways as urban pollution (residential, industrial, commercial, recreational) avoided more often or being addressed at source Reduced sediment loads through improved site management practices Water quality shown to be improving through results of chemical and biological monitoring More community sectors aware of sources of pollutants and actively avoiding or minimising production of pollutants Reduced quantity of stormwater flows (through water capture and reuse) Reduced velocity of stormwater flows	Number and types of pollution sources and estimated loads detected (catchment audit). Number of sediment sources and estimated loads (catchment audit) Percentage of time when water quality meets water quality objectives at key monitoring sites. (Water quality Monitoring) Pollution loads at key monitoring sites (water quality monitoring) Percentage of respondents able to identify pollution sources and personal actions taken to avoid pollution (community survey) Percentage of local businesses with environmental management



	into and within creek lines (through intervention, detention ponds/wetlands, etc.) Creek flows unimpeded or with designated environmental flow allocation	plans See also Flow monitoring
Objective 2. To maintain and enhance waterway features, flows and tidal interchange of the Lagoon	Lagoon with variety of aquatic features providing diverse habitats Tidal interchange with Lagoon supports healthy ecosystems Floodway capacity meets contemporary guidelines for floodplain management.	Area of the lagoon with intact aquatic habitat (habitat assessment) See flow monitoring
Objective 3. To maintain and enhance waterway features and return creek corridors and channels to a more natural state. *	Creek channels remediated to more natural state with riffle and pond sections, floodways and floodplains intact and meeting contemporary guidelines and with a range of available aquatic habitats Abstraction of surface and groundwater tightly controlled with groundwater resource approaching known sustainable level Barriers to movement of fish and other aquatic organisms removed (other than Manly Dam) Creek banks remediated with erosion reduced Riparian native vegetation providing well-structured buffers at least 10m wide between waterways and developed areas wherever feasible Creek corridors providing native animal habitat and greater connectivity to larger bushland areas	Percentage of creeks in a natural state with riffle and pond sections. (Riparian evaluation) Percentage of floodplain alienated from water courses through flood mitigation works Water extraction rules that are based on desired flow regimes. (Flow monitoring) % of stream length alienated from lower catchment by barriers to fish passage (riparian evaluation) % of the length of creek banks where erosion is reduced through vegetative or 'soft engineering' (riparian evaluation) % of creek length with vegetated buffers at least 10m wide (riparian evaluation)
Goal 2. <i>Open space, natural landscape features and waterways can support on-going high quality passive and active recreation and related community education.</i>	Amenity value and recreational use of the catchment meet the community's expectations for safe and enjoyable use. A catchment community which understands, appreciates and is proud of the catchment and the way it looks.	Level of satisfaction with recreational facilities and landscape features (Community survey) Degree of pride in the catchment landscape expressed by the catchment community (Community Survey)
Objective 4. To protect catchment values and manage natural settings and open space to facilitate appropriate recreation	Escarpment, steep slopes and other environmentally sensitive areas protected (through planning instruments) Bushland reserves (Open Space) with weeds and pests controlled; tracks	The extent and quality of each terrestrial and aquatic habitat type (habitat assessment) % of respondents able to correctly answer a question on local ecology (Community



<p>and tourism and act as an educational resource.</p>	<p>well maintained and with minimal erosion; and minimal degradation from controlled recreational use Community aware of values of natural areas, caring for them and involved in their management Developed parks, playing fields (Open Space) well maintained with no litter and reduced transport of nutrient and toxic pollutants in run-off; All golf courses with total water cycle management and EMPs (consistent with ISO 14000) in place, monitoring and reporting to public regularly on practices Park and golf course vegetation with more native species providing well structured buffers and corridor links to streetscapes and larger bushland remnants Users of developed parks, playing fields and golf courses more aware of the environmental impacts and benefits of the areas and more involved in their management</p>	<p>survey) Number of community members involved in restoration, monitoring and education actions The extent to which corridors provide sufficient habitat to allow target animal species to move between larger habitat areas. (habitat assessment)</p>
<p>Goal 3. <i>Natural resources are managed and conserved to enhance and sustain desired biodiversity, heritage and other catchment values.</i></p>	<p>Bushland and riparian area and condition are sufficient to sustain threatened species and beneficial ecosystem processes Cultural values and heritage features are understood, appreciated and protected.</p>	<p>The extent and quality of each terrestrial and marine habitat type. (Habitat assessment) The number of heritage features lost or damaged (council data) The number of people involved in heritage related events. (council data)</p>
<p>Objective 5. To manage and control, where practicable and beneficial, introduced species having adverse impact on native flora and fauna and catchment values.</p>	<p>Terrestrial and aquatic weed species managed and not spreading from urban areas. Pest animal species managed in environmentally sensitive manner All community sectors more aware of weed and pest problems and taking action to control and reverse the situation over time. Reduced use of chemicals and toxic substances to control weeds and pests in compliance with the Pesticides Act (1999). Progressive removal and replacement of weed species with native species.</p>	<p>Area of infestation of weeds by species. (Habitat assessment) Area of bushland covered by primary and maintenance rehabilitation work. (Habitat assessment) Community survey Volume of chemicals per unit area used to treat weeds and pests. (Council data)</p>
<p>Objective 6. To</p>	<p>Encroachments on creek lines by</p>	<p>Percentage of creek line with a</p>



<p>maintain, and rehabilitate where practicable, natural habitats along waterways and throughout the catchment.</p>	<p>urban development reduced and virtually eliminated Better structured native (local provenance) vegetation forms, adequate buffers (40m wide wherever possible) between developed areas and creek lines and waterways Increased area of buffers linked to remnant patches and more extensive natural bushland areas Barriers to animal movement minimal Increased range of aquatic and terrestrial plant communities and animal habitats Increased area of suitable plant communities and habitats</p>	<p>buffer protected by planning controls (riparian assessment) The extent and quality of each terrestrial and marine habitat type. (Habitat assessment) The extent to which bushland areas, corridors and riparian corridors are protected by adequate buffers. (Habitat assessment) The extent to which corridors provide sufficient habitat to allow target animal species to move between larger habitat areas. (Habitat assessment)</p>
<p>Objective 7. Manage and enhance native vegetation environment to ensure viability.</p>	<p>Large bushland areas are in good condition with disturbed areas rehabilitated Significant communities and rare and threatened species and ecological communities conserved and protected Streetscapes, urban parks, and private properties each providing increased contribution to ecological corridors and amenity. More community groups are active in co-ordinated rehabilitation and management of specific areas</p>	<p>The extent and quality of each terrestrial and marine habitat. (Habitat assessment) The extent of each habitat type is represented within protected areas, reported as a proportion of pre- 1750 area. The extent to which corridors provide sufficient habitat to allow target animal species to move between larger habitat areas. (habitat assessment) Number of groups involved in rehabilitation and management</p>
<p>Objective 8. Acknowledge and protect Australian cultural values and heritage sites.</p>	<p>Aboriginal representatives and other interest groups more involved with management and decision-making processes relating to cultural sites and heritage features More community sectors (local and visiting) aware of cultural values and heritage features and acting responsibly to conserve and value them</p>	<p>See stakeholder evaluation</p>
<p>Goal 4: <i>To enhance the pursuit of the Goals 1,2 and 3 through ongoing 'state of the art' integrated and adaptive management of the catchment and its resources.</i></p>	<p>Continued influential participation of key stakeholders who have strategic capacity to support integrated decision making and share sustainable benefits. Improved targeting and cost effectiveness of activities to sustain the catchment's natural resources. An integrated monitoring framework</p>	<p>See stakeholder evaluation</p>



	which benchmarks catchment health, informs adaptive management needs, and effectively communicates relevant outcomes to all.	
Objective 9. To adopt an integrated and adaptive approach to the management, human use and arising impacts on the values of natural and built resources.	<p>Environmental improvements are gained in shorter timeframes</p> <p>Improved co-ordination, co-operation and communication within and between Councils and Agencies</p> <p>Community sectors more knowledgeable and active in sustaining natural resources.</p> <p>More community sectors have ownership of problems, are taking responsibility, and have enthusiasm to address them.</p> <p>Planning, assessment, monitoring and review processes are standardised and accepted as part of management cycle</p> <p>Cost savings through improved partnerships and effort and feedback to management from monitoring information</p>	<p>See stakeholder evaluation</p> <p>See stakeholder evaluation</p> <p>% of respondents able to answer a question on local ecology (local survey)</p> <p>Number of community members involved in restoration, monitoring and education actions</p> <p>See stakeholder evaluation</p> <p>See stakeholder evaluation</p>

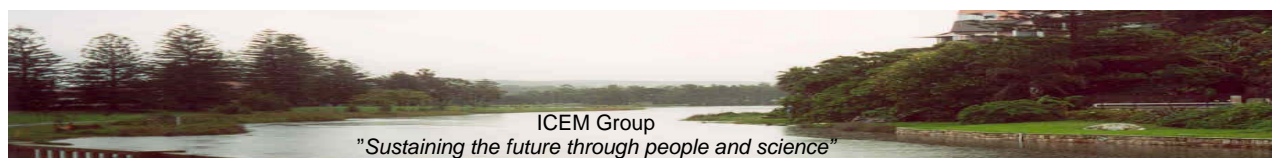
5.6 The Activities to Sustain the Catchment

The 'Current and Completed Activities within Plans and Strategies' Table in Volume 2 of this report contains specific details of each of the activities within each component strategy of the ICM Strategy. These details have been brought together from the existing plans and strategies and supplemented by officers and staff of the member agencies and councils of the Sydney Water-Manly Council Partnership Committee. The activities have been reviewed and subsequently grouped together within each of the 22 Strategies to indicate their purpose and relationship in achieving the catchment goals and objectives.

To the extent possible, the agency or organisation principally responsible for each activity has been highlighted along with the timeframes currently planned to complete the activity. The stage of progress (planned, initiated, ongoing or completed) is also indicated. Again to the extent possible, the principal organisations with responsibility for implementation have indicated the cost and/or resourcing level required.

5.7 Information, Monitoring and Reporting Needs

The Manly Lagoon Catchment ICM Strategy and Evaluation Study, from which this ICM Strategy has been developed, found that water quality monitoring and other studies and assessments were generally inadequate to provide the level of information required for catchment management (see Chapter 3). The Expert Panel recommended the establishment of an integrated monitoring and reporting system which could provide an

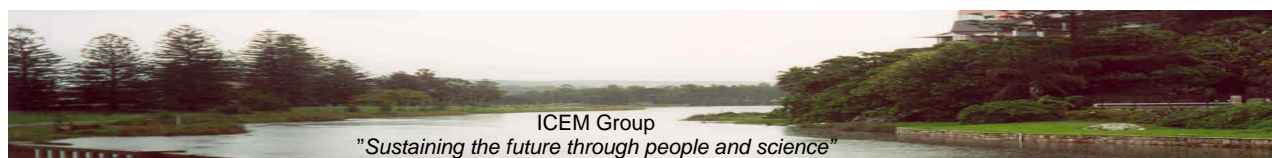


adequate and necessary standard and level of monitoring and reporting. The integrated monitoring and reporting system would, among other roles:

- Benchmark the current condition of the catchment using selected indicators which enable clear assessment of future progress towards goals and objectives;
- Bring together existing and newly required monitoring data and information into one integrated GIS based system capable of open and unfettered use by all interested stakeholders;
- Identify and confirm 'hot spots' and targets for remediation in the catchment;
- Through time, help to separate real progress towards goals and objectives from perturbations and freak influences including very low probability weather events;
- Confirming the status of key waterways in relation to the community goals and any further level of improvement required;
- Allow existing and new monitoring data to be located in relation to catchment influences and weather events;
- Document and clearly communicate progress in selected key performance indicators;
- Enable clearer definition of issues and necessary responses;
- Be capable of measuring cost effectiveness, thereby improving and better focusing investment through the ICM Strategy overtime;
- Become a tool for improved decision making through action learning and better informed adaptive management processes; and
- In the medium and longer term, simply informing the catchment community and other stakeholders of the extent of their success.

With further and particular respect to water quality, the Integrated Catchment Monitoring and Reporting System should enable efficient and less duplicatory water quality monitoring needs and fill currently identified additional data requirements. It should enable:

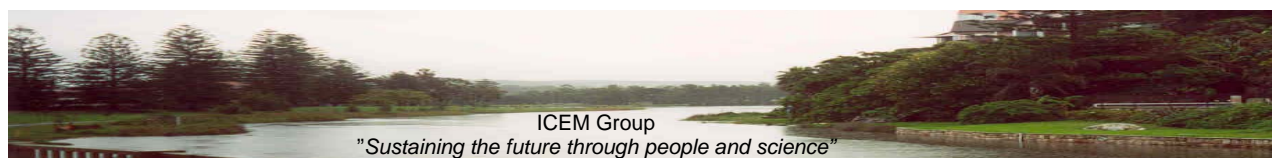
- analyses of data for source-contamination relationships;
- identification of knowledge gaps in source-contamination relationships;
- identify additional water quality information needs relating to important sources (monitoring, catchment combing, pollution load studies); and
- identify other information needs relating to other community and natural values and the agreed catchment goals.



5.8 Recommended Additional Studies

It is recommended that resources be found to undertake the following additional studies which have been identified as priorities through this Study. The results of these three studies in particular would significantly assist the further development of the ICM Strategy and future investment decisions. The additional studies are:

- The determination of the nature and relative contribution of exfiltration and infiltration in private sewer lines to water quality decline in the catchment;
- The determination of the nature and relative contribution of contaminated lands, particularly the old tip sites, to ground water degradation; and
- The impact on water quality in Queenscliff Pool of discharges from Manly Lagoon which are currently below standards for Primary Recreation.



6. Water Quality in the Catchment

6.1 Introduction

Considerable focus was placed on water quality as part of the Manly Lagoon ICM Strategy and Evaluation Study. The work involved evaluating current water quality monitoring, data and trends and then considering the implications of the Australian and New Zealand Environment and Conservation Council (ANZECC) and the Agricultural and Resource Management Council of Australia and New Zealand (ARMCANZ) Guidelines for Fresh and Marine Water Quality which form part of the National Water Quality Management Strategy for Australia and New Zealand.

The steps involved in the evaluation included:

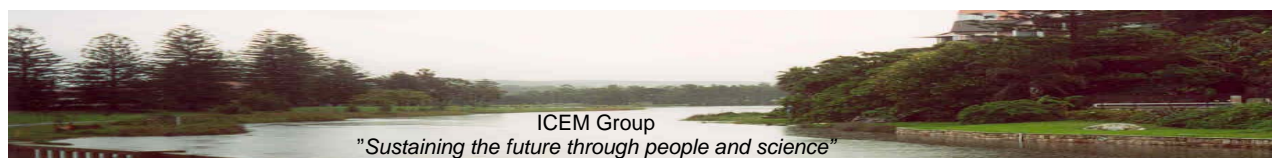
- Identifying and analysing current data available in reports and databases;
- Analysing and assessing integration needs of available GIS Information for the catchment;
- Reviewing and assessing existing data (suitability and gaps);
- Analysing data and comparing to water quality to be pursued, determining appropriate triggers;
- Analysing trends;
- Identifying the extent of necessary water quality improvements;
- Assessing information, monitoring and reporting needs; and
- Considering the implications of the ANZECC Guidelines.

Full details of this work may be found in the separate Volume 2 of this Report. It should also be noted that there exists considerable opportunity to progress this work by inputting the derived data summaries onto a data management framework with an interactive spreadsheet, interrogation and end-user recall facilities.

The work also supports the development and implementation of the proposed ICM Monitoring and Reporting System which is outlined in Chapters 5 and 7. Ultimately the system could be used to develop sub-catchment specific water quality triggers that model lagoon responses to catchment interventions. The prospects for this are considered in Section 6.8.

6.2 Identify and analyse current data available in reports and databases.

Table 6a summarises all available water quality and related monitoring program data identified for Manly Lagoon and its tributaries between 1975 and 2002. Of this period almost continual monitoring has been undertaken since 1990. In total 29 monitoring programs surveying water, sediment, flora/fauna, flows, tides and geomorphology have been summarised and 42 reports with indirect application of the monitoring data listed (see Volume 2).



There exist a total of 12 broad sub-catchments running into Manly Lagoon. Eight of these within Manly local government area and the remaining four are located within Warringah local government area. Two of these sub-catchments (industrial) have been monitored and modelled between 2000 and 2002 (UWS).

Water Quality surveys have typically been conducted in Manly Lagoon and its major tributaries draining sub catchments from Manly and Warringah Local Government Areas (see Volume 2: Map 1). The EPA has also undertaken beach watch surveys around the exit point of the Lagoon. The majority of surveys have been undertaken to assess the quality on the Lagoon in regards to the desired quality for the designated use or value. The exceptions were the surveys undertaken by the Water Board (sewage overflow and exfiltration monitoring), Patterson and Britton (Hydrological and flood analysis) and UWS (stormwater load analysis). Limited surveys have also been undertaken for flora and fauna.

The quality of field surveys and laboratory analysis was determined using a ranking of analytical and quality control procedures (see Volume 2). A ranking based on the analysis is given in Table 6a.

Table 6a: Summary of Water Quality Survey Data for Manly Lagoon

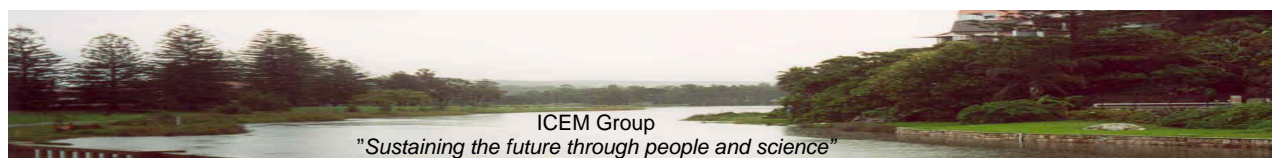
Water Quality Survey	Quality of data*	Quality Category	Value to Catchment Management	Value Category
	<u>Laboratory Quality Guide</u> Highest 4/5 <i>Lowest 1/1</i> <u>Field Quality Guide</u> Highest 3/3 <i>Lowest 1/1</i>		General Comments	
Water Board / Sydney Water / AWT – 4 reports.	Laboratory Score: 4/5 Comments: High level of lab quality. NATA certified. Field Score: 3/3 Comments: All field methods referenced with 3 replication taken for each sample.	high	Monitoring typically specific to sewer exfiltration from sewer sub-catchments 2. Limited interpretation of spatial and temporal Lagoon functioning. 3. Identifies hotspots for sewer remediation works. 4. Would benefit monitoring process to overlay sewer subcatchments and	medium



			stormwater subcatchments onto 1 GIS system.	
EPA / SPCC - 2 reports	Laboratory Score: 4/4 Comments: Laboratory procedure in accordance with Standard Methods (APHA, 1999) Field Score: 3/3 Comments: High quality of field analysis.	high	1. Specific to health and safety conditions of Manly Beach swimming at 4 sites. 2. Allows for links between Manly Lagoon and its influence on beach fecal contamination rate. (Refer to Sydney Water 94; 96 and 2001) 3. High relevance to sewer contamination on Beach at sampling time. Accuracy of sewer contamination loadings in Manly Beach low given no storm event monitoring and the nature of sewer transportation in wet weather.	low
University of Western Sydney - 4 Reports	Laboratory Score: 4/4 Comments: Standard methods referenced. Regular interlab assessment undertaken by University. Field Score: 3/2 Comments: Field methods referenced in accordance with standard methods (1990).	high	Loads monitored 1. Fingerprints industrial and commercial landuse stormwater pollutant load characteristics from before and after "Treatment Train" interventions. 2. Evaluates pollutant specific load reduction capabilities of the "Treatment train" involving at source to end of pipe stormwater management.	high



<p>Manly Hydraulics Lab – 4 reports.</p>	<p>Comments: Typically No Lab analysis undertaken Field Score: 2/2 Comments: Monitoring instruments detailed and computer modelling processes given.</p>	<p>high</p>	<p>1. Monitoring typically specific to hydrological investigations. Viewed along side relevant water quality monitoring data may provide relations between flooding and pollutant concentrations. Indicates of relationship between Dam/ Creek/ Lagoon, ocean and flooding. Computed-based flood forecasting system devised.</p>	<p>low</p>
<p>Patterson Britton & Partners – 3 reports</p>	<p>Laboratory Score: 4/5 Comments: High level of certainty with NATA accredited analysis. Field Score: 3/3 Comments: High level of quality control with sediment sampling.</p>	<p>high</p>	<p>1. Typically Specific assessment particular issues for remediation, i.e. fish kill 2. Could link sediment hotspots to stormwater load generation from landuses.</p>	<p>low</p>
<p>Warringah Council / Manly Council / Laxton- 12 reports</p>	<p>Laboratory Score: 3/1 Comments: Analytical methods referenced from 1974. Field Score: 2/1 Comments: collection methods detailed. Field Instrumentation given.</p>	<p>medium</p>	<p>1) Reports detail trends over time and space in lagoon body. If surveys were dated it would indicate volumetric Lagoon function over time and be related to rainfall and catchment loads. 2) Data serves little function in determining source of poor lagoon water quality conditions. 3) Compares Lagoon</p>	<p>medium</p>



			compliance ratios with ANZECC guidelines. Compares Manly Lagoon function with other Northern Beaches Lagoon functions.	
Consultant Reports – 6 reports	Laboratory Score: 4/4 Comments: High level of lab assessment and data quality Field Score: 3/1 Comments: High level of confidence in field methods.	medium	1. Data typically confirms high pollutant concentrations in Manly Lagoon surface water. 2. Limited value for calculating landuse loads. Sampling does not define pollutant sources or BMP success / failure.	low
Non government Organizations – 7 reports.	Laboratory Score: 2/1 Field Score: 2/2 Sampling typically undertaken by community volunteers / students	low	1. High variability between reports 2. Typically dry weather monitoring that may allow for load calculations from specific study areas.	low
University Undergraduate Students - 5 reports	Laboratory Score: 2/1 Comments: Low level of quality assurance with lab assessment techniques Field Score: 2/1 Comments: Instruments typically tabulated and calibrated before sampling by students.	low	1. Typically Compares monitored data with previously collated data to verify trends over time. 2. Assists in detailing pollutant hotspots and may allow for load calculations with relevant rainfall data.	low



The Quality Assessment was based upon the number of Quality Control Procedures used. Both laboratory and field analysis quality scores were based on two parts with the following ranking.

Laboratory Analysis	Item	Rank
Methods Assessment	Appropriate Standard Methods Used	4
	Methods Referenced	3
	Methods Given	2
	No methods recorded	1
Quality Control	NATA Accreditation	5
	Interlaboratory Analysis	4
	Replication	3
	Data processing	2
	None	1

Field Analysis	Item	Rank
Methods Assessment	Referenced	3
	Given	2
	None	1
Quality Control	Replication	3
	Data processing	2
	None	1



6.3 Analysis and integrate available GIS information for the Catchment

GIS information for the catchment appears to be widely dispersed across organisations, utilising at three software systems. There also appears to be a number of barriers to integration across organisations at this time.

Manly Council, Warringah Council, Sydney Water, National Parks and Wildlife Service, Department of Land and Water Conservation and the Roads and Traffic Authority all have GIS systems with data layers of relevance to the management of Manly Lagoon.

Manly Council uses Map Info for data management of roads and drainage, local environment planning instruments, street numbers and allotment surface areas. Their system is in an early stage of development with no previous application of water quality and quantity indicators.

Warringah Council uses Genomap for their GIS system. Their system is again applied for data management of roads and drainage, local environment planning instruments, street numbers and allotment surface areas. Warringah's system is more sophisticated than Manly Council's with end user interfaces giving all necessary council staff capabilities to generate and modify relevant maps. There has been a recent initiative by Warringah to incorporate natural system aspects into their database such as vegetation communities, soil types including acid sulphate soils, natural creeks lines and buffer zones. Warringah recently acquired a data management system that models water quality and quantity features of their lagoons and tributaries, including Manly Lagoon. The model suggests Manly Lagoon has remained stable but in a poor condition over the past 10 years.

Sydney Water uses Arc Info and have sewer sub-catchments characterised and prioritised for overflow, exfiltration and infiltration rehabilitation. Roads and Traffic Authority use Arc Info and have data layers of roads, aerial photography, census data, signage and other non-specific information (speed cameras etc). National Parks and Wildlife Service use Arc Info and have detailed data layers of areas threatened species, flora and fauna, weeds all with high relevance for the management of Manly Lagoon. Department of Land and Water Conservation use Arch View and has relevant data layers of Acid sulphate soils, Heritage (Indigenous information is not accessible), and areas of salinity issues.

There exists considerable economic and environmental benefits for all stakeholders in integrating all available data layers into the one common database assessable by all. There appears, however, a present and considerable resistance involved with data exchange across organisations.



6.4 Review / assess quality of existing data (suitability and gaps)

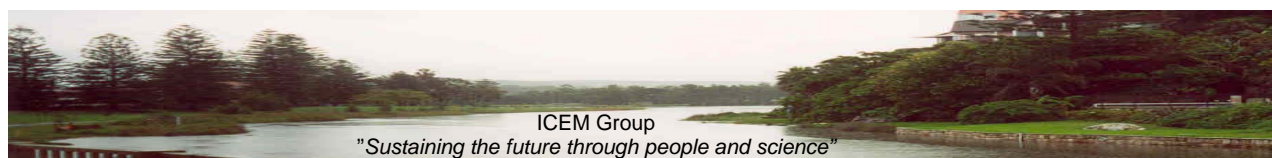
Analytical quality ranged from high to low, providing some value to understanding Lagoon function, but in all cases limited in regards to the value for catchment management.

The majority of analytical work has been conducted by Manly and Warringah Councils using the services on Laxton consultants. This work reported on the status of the Lagoon in regards to ANZECC guidelines for the designated uses of the waterway. The surveys were not designed to report on Lagoon function (metabolism, nutrient dynamics) or catchment dynamics. They did however, provide a comparison between Lagoon quality and that required for recreation and aquatic ecosystems.

The Monitoring reports reviewed for Manly Lagoon undertaken between 1975 to 2002 (summarised in Table 6.1) vary widely in quality and value to the management of Manly Lagoon. The reports range from school students to post graduate research projects, from consultants to government and non-government organisations. All reports differing in their objectives, sampling and analysis methods. Moreover, presentation of results and actions relating to these findings are often isolated to the discipline that contracted the monitoring in the first place.

There exists numerous generalised observations of potential pollutant sources but few monitoring reports accurately quantify pollutant loadings, specific 'hotspot' locations nor impacts on Manly Lagoon. The monitoring programs summarised in this report are therefore limited in quantifying human impacts on Manly Lagoon or achievements in the quest to rectify human impacts for 'community value' preservation.

In the absence of total catchment storm event monitoring, the transferral of data collected from other urbanised catchments is necessary. Inherent with transferring previously collated data are levels of uncertainty as recent storm event monitoring in the area has shown (UWS. 2002). In order to increase the level of certainty this modelling approach could be calibrated with relevant monitoring programs sharing similar temporal and spatial characteristics. In addition, monitoring efforts in the future would benefit from sampling in those periods of highest pollutant transportation (during storm events) in sub-catchments previously not monitored for storm events (refer to map 1 and table 1 to determine gaps). Sub-catchments could be modelled and calibrated through a common monitoring approach and ranked in terms of pollutant significance to receiving waterways values. This inturn would facilitate site-specific implementation and evaluation for adaptive management and continual improvements.



6.5 Analyse data and compare to water quality to be pursued, determining appropriate triggers.

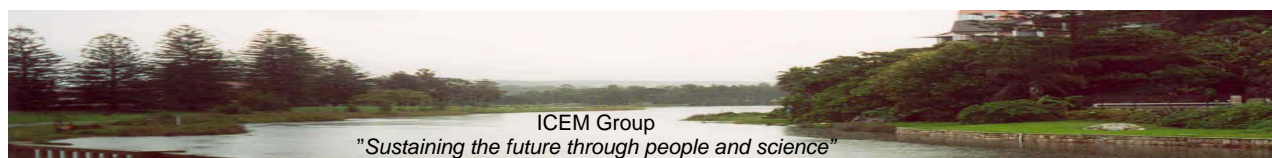
Trigger indicators can range from complex chemical, physical and biological indicators to simple public perception surveys and economic modelling instruments. Regardless of the parameter or technique to be effective the triggers should reflect a measurable attribute of an indicator and be measured over a long enough period to establish trends (US EPA. 2002).

The Sydney Northern Beaches Stormwater Management Plan summarises environmental standards from ANZECC guidelines and those devised from site specific monitoring by Dr J Laxton. Dr Laxton (1992-2002) compares monthly monitoring data compliance against water quality guidelines developed by his firm for Manly Lagoon. These guidelines are based upon an estimation of the pre European condition of the water body (pp 20-26). From these guidelines short and long term objectives are devised (pp 40-47) recommending a percent reduction of specific parameters. However no formal monitoring framework exists to measure such changes nor account for intervention successes.

Streamwatch and Beachwatch provide over a 10-year history of data for Manly Beach, Manly Lagoon and its tributaries. This monitoring data provides compliance ratios for primary contact as set by ANZECC (1992 - 99). These standards are also limited in determining appropriate trigger mechanism, as pollutant exceedance rates during storm events are not accounted for.

The guidelines and recommendations detailed in the above documents provide a series of snap shots at specific points in time across the 18 km² catchment. Manly Lagoon exists as a system in constant cyclic change, from seconds to decades across various sections of Manly Lagoon and its tributaries. No suit of parameters or catchment conditions are likely to ever repeat. Water Sampling and the development of intervention triggers without consideration of these changes may promote monitoring with meaningless goals and result in ill-informed actions. Moreover there has been no attempt to cost benefit or integrate a social and economical triggers with water quality indicators to obtain a true account of intervention successes.

Processes for developing monitoring / modelling frameworks now exist and are outlined in specific protocols. The US EPA "*National Management Measures Guidance to Control Nonpoint Source Pollution from Urban Areas*" lists a comprehensive list of monitoring / modelling processes that characterise catchment conditions, management triggers and responses to management options. This can be viewed at www.cwp.org. The University of Western Sydney has also been developing intervention triggers site specific to Balgowlah Industrial Estate and Manly Corso over a 3 year, ongoing, storm event-monitoring program.



6.6 Analyse Trends

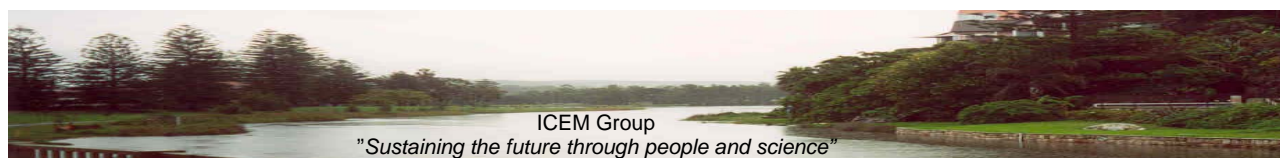
There exists little in the way of clear and concise trends across the 25 years of monitoring programs for Manly Lagoon catchment. The significant differences in monitoring aims, methodologies, data interpretation and the limited storm event monitoring add to the challenge of accurately determining and comparing pollutant trends. There appears little doubt however, that Manly Lagoon does not meet its required quality for recreation or aquatic ecosystems.

Dr Laxton quotes nutrients have remained at “more or less the same over the 8-year sampling period”. For Manly Lagoon total nitrogen results ranged between 3.08 and 0.046 mg/L generating a mean value between 0.5 and 1mg/L for the period between 1994 and 2000. ANZECC Guidelines indicate above 0.1mg/L total nitrogen to be of concern for the protection of aquatic ecosystems. Total phosphorus results ranged between 2.388 and 0.006 mg/L generating a mean value between 0.06 and 0.14mg/L for the period between 1994 and 2000. ANZECC Guidelines indicate above 0.05mg/L total phosphorus to be of concern for the protection of aquatic ecosystems. Laxton’s monitoring showed nutrient concentrations were typically very high in wet weather.

Warringah Catchment Modelling system indicates poor but stable water quality conditions over a 10 year period. However, their modelling approach weighed heavily on the monitoring undertaken by Laxton 1993-2001. In contrast, Streamwatch data shows TN readings regularly above levels of concern for Manly Lagoon and above those derived from Laxton’s monitoring.

A consistent trend across the monitoring programs is the “ecologically dangerous” dissolved oxygen readings. Manly Hydraulics Lab has continuous instream monitoring stations that typically show dissolved oxygen readings below 2 mg/L over the daily cycle. ANZECC Guidelines indicate that dissolved oxygen readings below 5mg/L are of serious concern for aquatic health. Increases in dissolved oxygen are observed after heavy rain and incoming tidal seawater, however, revert to a consistent ‘dangerously low’ dissolved oxygen readings. This is supported by most monitoring reports reviewed in this report.

Most monitoring reports are consistent in that the quality of water deteriorates down Burnt Bridge Creek, Manly Creek, and Brookvale Creek. Pollution indicators such as nutrients, metals, pathogens, sediment, and oxygen demanding materials are at highest concentrations around the base of the tributaries where flow meets Manly Lagoon, slow and pollutant loadings settle. Sediment monitoring reports also reveal highest pollutant concentrations around these points. This indicates that the sediments themselves may be a significant source of pollution.



6.7 Identify extent of necessary water quality improvements

Page 43 – 48 of the Sydney Northern Beaches Stormwater Management Plan details short and long term water quality targets and sets out management objectives for achieving these targets (appendices 5). The report suggests nutrient and gross load reduction by 5 and 15% respectively for the short term and 30 and 70 % reduction of nutrient and gross loads for the longer term. As previously stated any such benchmarking without accounting for wet weather pollutant exceedance or having formal mechanisms for evaluation may result in ill-directed resources and / or management interventions.

The development of an integrated and total catchment monitoring and assessment framework will be critical in facilitating and measuring successes to achieve water quality improvements. Included in this approach would be appropriate modelling of Manly Lagoon required to understand Lagoon responses to pollutant loadings and remedial interventions.

Adopting principals of Water Sensitive Urban Design incorporating options such as on-site detention and stormwater reuse have increasingly become accepted as viable (economic and environmental) alternatives to the traditional methods of stormwater management. The monitoring/modelling framework should encompass these aspects and promote innovative solutions in the planning phase of Council's development framework.

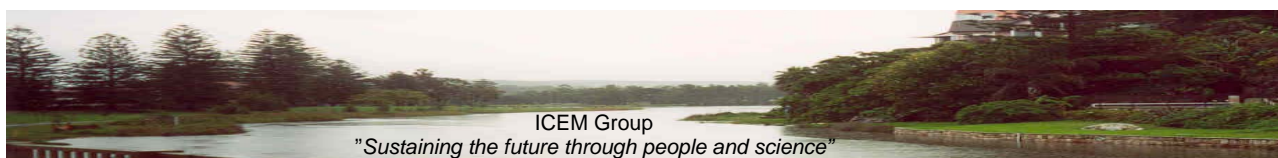
6.8 Implications of ANZECC Guidelines

The following summarises key aspects of the 2000 ANZECC water quality requirements, particularly in relation to the catchment values identified for the Manly ICM Strategy.

The Guidelines are structured according to a water quality framework, guided by environmental values. The framework includes:

- Clear definition of environmental values or uses;
- Good understanding of links between human activity and environmental quality;
- Setting unambiguous management goals;
- Identify appropriate water quality targets; and
- Effective management frameworks: including cooperative, regulatory, feedback and auditing mechanisms.

Each environmental value has associated 'guidelines' or 'trigger values' for substances likely to impair water quality. If these values are exceeded, they may trigger an investigation or management response. If two environmental values apply, then the more conservative should be used. Management goals, specifying what is to be protected, and defined according to community needs and desires, can then be specified in a way that is achievable, measurable, and realised through clear management plans.

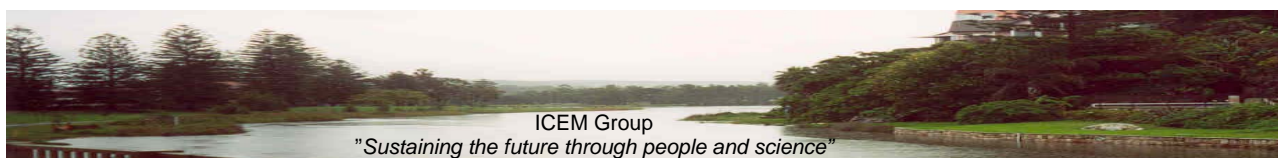


As local environmental factors can alter the effects of physical or chemical parameters, a framework allows users to move beyond 'single numbers' to locally refined guidelines. Risk-based decision frameworks are provided, where possible, to help users refine trigger values for local or regional conditions. These frameworks are developed for aquatic ecosystem values, and hinge on the use of guideline 'trigger values' rather than the 1992 guideline 'default values'. If the level exceeds the trigger value, managers can seek further information on whether the default trigger is appropriate. For toxicants, an extensive database and software package is included on CD-ROM to calculate locally appropriate trigger values.

Below are some suggested recommendations for developing the use of the ANZECC Water Quality Guidelines based upon interpretation of points raised during the Expert Panel sessions.

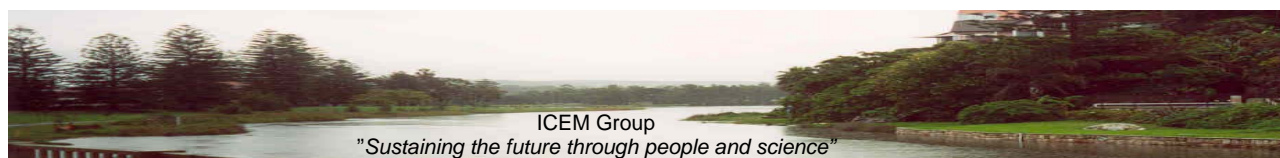
6.9 Recommendations relating to ANZECC Guidelines

1. Build upon the processes and methodologies of ANZECC Water Quality Guidelines in an integrated monitoring strategy undertaken by all stakeholder organisations and community, within an adaptive management cycle for Manly Lagoon and its catchment.
2. Utilise and adapt triggers and methodologies of ANZECC Guidelines as they relate to community values of ecosystem protection in the Manly Lagoon catchment, secondary contact recreation in feeder streams and primary contact recreation in Manly Lagoon.
3. Draw upon the ANZECC Guidelines methodologies as a structured approach to incorporate recent and ongoing monitoring, and trigger values exceeded, to target inquiry and management activity. This includes monitoring undertaken within the UTS Freshwater Ecology Program, Streamwatch, and all other researchers and community groups.
4. Establish means to integrate biological and physico-chemical monitoring with local hydrological dynamics, including velocities, hydrograph characteristics, related 'first flush' and quality/quantity dynamics, and impacts on aquatic, riparian and terrestrial ecological associations.
5. Identify reference sites for long-term comparative monitoring to benchmark changes in ecological indicators and physico-chemical stressors throughout the catchment, along with responsive medium-term monitoring of hot-spots and dynamic changes in land use impacts and sewer overflows.
6. Build upon the the ANZECC Guidelines for recreational water quality and aesthetics, particularly given that these are not as developed in terms of risk-based decision frameworks as the guidelines for ecological protection, and may be updated to reflect World Health Organisation recommendations.
7. Integrate the processes suggested in the ANZECC Guidelines for using trigger values with the process suggested in the ANZECC monitoring guidelines,



particularly in relation to developing an agreed understanding/model of the system and its critical processes.

8. The process of applying the ANZECC Guidelines to Manly Lagoon catchment should include a thorough participatory assessment with all stakeholder organisations and groups of:
 - Clarify primary management aims based upon identified community values and levels of protection and ecosystem condition for the Manly Lagoon and catchment;
 - Choose 'assessment objective' and 'balance of indicator types' for biological assessment;
 - Establish the extent of local or site-specific biological effects and local reference data for chemical and physical stressors, toxicants, and sediments;
 - Identify indicator protocols, design and analysis, for addressing management aims and community values in a coherent and achievable manner;
 - Choose appropriate statistical bands for toxicant triggers, based upon levels of protection and confidence;
 - Identify means needs for further clarifying triggers, and criteria for management decisions by involved stakeholders.



7. Ensuring a Healthy Catchment through and ICM Monitoring and Reporting System

7.1 Overview

This Chapter provides more details on the potential suite of indicators for the Manly Lagoon and Catchment ICM Strategy. It outlines an initially recommended structure for an Integrated Catchment Monitoring and Reporting System which groups the recommended indicators according to the monitoring process to be used into the seven monitoring programs listed immediately below. To supplement these monitoring programs this chapter also identifies some additional indicators which may be derived from data generally held by local councils.

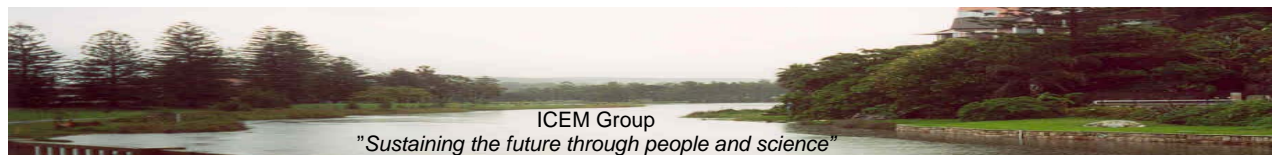
- Water Quality Monitoring;
- Catchment Audit;
- Community Survey;
- Flow Monitoring;
- Riparian Evaluation;
- Habitat Assessment; and
- Stakeholder Evaluation.

It is recommended that the Sydney Water - Manly Council Partnership consider establishing an Integrated Catchment Monitoring and Reporting System for the Manly Lagoon catchment. Base information would be placed on a GIS and protocols established for input and use by Partnership members. The System would also consist of integrated facilities and procedures to enable the exchange of natural resource management and planning information for catchment managers and stakeholders. Optimally, this would operate on a sub-catchment basis with open availability and transparency of data and information on catchment health and also on progress towards the catchment goals and objectives. This could be achieved though systems such as the newly developed and commercially available Catchment Information System (for further information see catchment.com) which features web-based information exchange and institutional arrangements to ease implementation.

7.2 Water Quality Monitoring

Indicators Covered

- % of time when water quality meets water quality objectives at key monitoring sites;
- Number of events that water quality in Manly Lagoon does not meet objectives for primary recreation; and
- Pollution loads at key monitoring sites.



Methods

The ANZECC Water Quality Guidelines include physical, chemical and biological water quality indicators and references to the methods used for measuring these. The measures selected will need to be determined from the water quality objectives. A series of 'key sites' will need to be monitored to provide the continuity of data.

Benchmarking

The ANZECC Water Quality Guidelines Water advocate the use of agreed water quality objectives as benchmarks. This is discussed further in a separate section of this report. Further work will be required to establish specific water quality objectives for waterways in the catchment. However, a substantial body of information exists from which such objectives could be determined.

Comments

Load based monitoring is only used for a single indicator. However, such data will also be of value in informing management actions.

7.3 Catchment Audit

Catchment Audits here refer to the types of audit carried out by local Council compliance Officers through inspections of industrial areas etc.

Indicators Covered

- Number and types of pollution sources and estimated loads detected;
- Number of sediment sources and estimated loads; and
- Percentage of local businesses with environmental management plans.

Methods

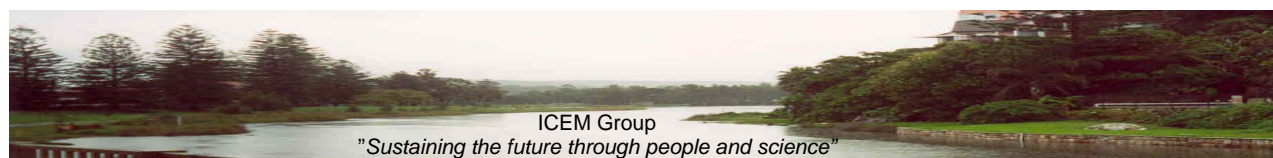
It is anticipated that Local Council officers will be carrying out inspections of premises and pollution sources in response to strategies 4 and 7. The data needed to inform these indicators can be collected as part of this process. The ability to estimate loads will vary between different pollutants. A consistent scheme for either estimating quantities or categorising sources will need to be developed so that trends can be determined. In reporting results, fluctuating levels of effort in undertaking catchment audits will also need to be taken into account.

Benchmarking

Audits of industrial areas and building sites have already been undertaken in parts of the catchment. These results may be able to provide a benchmark for improvement. Some data is also available on exfiltration from the Sydney Water sewerage system.

Comments

These indicators may appear to be superfluous for evaluating the strategy if rigorous load based monitoring is carried out. However, the two data sets will provide an



information base to guide pollution reduction programs by identifying priority pollution sources and highlighting unaccounted for pollution.

7.4 Community Survey

Several of the outcomes of the ICM Strategy are necessarily subjective and subject to changes in community values, particularly those relating to aesthetics and satisfaction. However, these can be quantified through the use of well-designed community surveys.

Indicators Covered

- % of respondents able to identify pollution sources and personal actions taken to avoid pollution;
- Community satisfaction with recreational facilities and landscape features; and
- Pride in the catchment landscape expressed by the catchment community.

Methods

Community surveys are frequently carried out by local government. The 'Who Cares' surveys undertaken by the NSW EPA, and the similarly based local survey by Manly Council, provide a good example of the methods used to investigate environmental knowledge and perceptions.

7.5 Flow Monitoring

In the majority of the catchment, water flow regimes are controlled by engineered structures. The first indicator is essentially evaluating whether the design parameters for these systems are based on recognised flow objectives and whether there is enough knowledge of catchment hydrology to provide a basis for such objectives.

The second indicator is evaluating whether flow objectives are being met.

Indicators Covered

- Water extraction rules, flood mitigation and stormwater management are based on agreed flow objectives; and
- Percentage of time during which flow objectives are being met for each water body.

Methods

Methods for monitoring stream flows and velocity are well established. A series of 'key sites' will need to be monitored to provide the continuity of data.

Further work will be required to establish specific flow objectives for waterways in the catchment. However, a substantial body of information exists from which such objectives could be determined.



Benchmarking

The components of the strategy that relate to water flows include floodplain management and ecological outcomes. The height, frequency and velocity of base flows and flows up to bank full height are recognised as being of great ecological significance as these are regular events, changes in which can have long term cumulative impacts. High flows are also important due to impacts of flooding and the importance of flooding to some species and ecological processes

7.6 Riparian Evaluation

Indicators Covered

- Percentage of creeks in a natural state with riffle and pond sections;
- Percentage of floodplain alienated from water courses through flood mitigation works;
- % of stream length alienated from lower catchment by barriers to fish passage;
- % of the length of creek banks where erosion is reduced through vegetation or 'soft engineering';
- % of creek length with vegetated buffers; and
- Area of the lagoon with intact aquatic habitat.

Methods

The riparian evaluation will require a field assessment of riparian vegetation, creek and channel stability, barriers to fish passage and habitat features in the Lagoon using rapid assessment techniques. The indicators can be derived from this information using desk top mapping of:

- Barriers to fish passage;
- A ranking of Creek bank and channel stability;
- Vegetated buffers of at least 10 metres; and
- Condition of riparian vegetation;

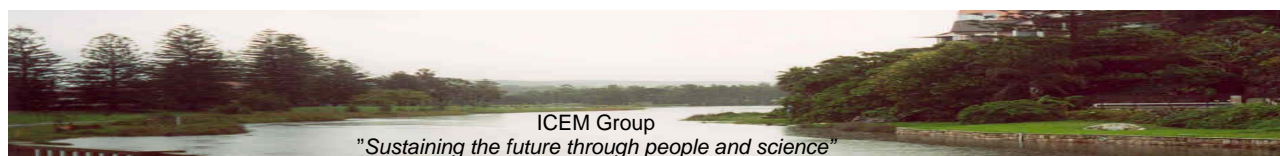
The condition of riparian vegetation, creek line and channel stability can be assessed through an appropriate guideline.

Benchmarking

Benchmarking will need to be carried out using the selected measurement methods.

Benchmarks for:

- % of stream length alienated from lower catchment by barriers to fish passage;
- % of the length of creek banks where erosion is reduced through vegetation or 'soft engineering';
- % of creek length with vegetated buffers; and



- Can be based on the maximum feasible stream length for each of the conditions measured.

Data collection / sources

This component of the monitoring program is ideally suited to community involvement in the collection of field data. Observers with limited technical training can carry out most rapid assessment techniques. Involving the community directly in monitoring will also complement the education and awareness components of the overall strategy.

Comments

Barriers to fish passage can include both habitat barriers as well as physical barriers. These will need to be characterised with reference to the habitat needs of species native to the catchment.

7.7 Habitat assessment

Indicators in this category have been developed to provide an evaluation of the progress towards outcomes under goal three and its related objectives. These are catchment scale outcomes and so their monitoring and evaluation is largely based on landscape scale indicators of habitat extent and condition, rather than measures specific to particular species.

At this scale, plant communities (both aquatic and terrestrial) can be used as a means of categorising habitat types. Stream habitats can also be categorised according to geomorphic characteristics. Specific reference should be made to threatened plant communities and the habitat of threatened species.

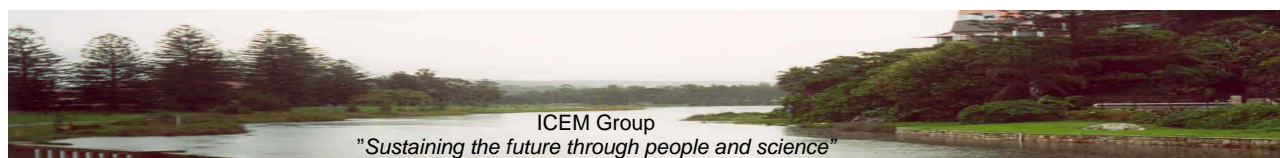
Indicators Covered

- The extent and quality of each terrestrial and aquatic habitat type;
- The extent of each habitat type is represented within protected areas, reported as a proportion of pre- 1750 area;
- Area of bushland covered by primary and maintenance rehabilitation work;
- The extent to which bushland areas, corridors and riparian corridors are protected by adequate buffers;
- The distribution (and where possible abundance) of non-local terrestrial, marine and fresh water species identified as pests, including translocated native pests; and
- The extent to which corridors provide sufficient habitat to allow target animal species to move between larger habitat areas.

Methods

A range of assessment methods for bushland quality exist and can be adapted to the Manly Lagoon catchment.

The adequacy of buffers depends on the type of impact and can be inferred from an assessment of condition and impacting activities. Current scientific evidence suggests



that a minimum of 20m width, and preferably 40-100m may be required, depending upon catchment objectives and values, and plant community structure.

Evaluation of corridors will require an understanding of the requirements of target species. The results for this indicator could be expressed in terms of the potential range of target species.

Benchmarking

Existing bushland and stream and estuary studies provide useful baseline information from which improvements can be demonstrated. However, it should be recognised that links between the long-term survival of native plant and animal communities and characteristics such as the area of plant communities and the width and character of connecting corridors and are not well established. Benchmarks that relate directly to the desired outcome of sustaining biodiversity will need to be developed as an understanding of requirements.

Data collection / sources

Much of the required information should be available through sources such as plans of management and site-specific studies for open space reserves. Ensuring that future studies incorporate a standard approach to characterising plant communities and their quality, will facilitate easier monitoring of these indicators. Where such data is not available, rapid assessment techniques could be adapted and implemented.

Comments

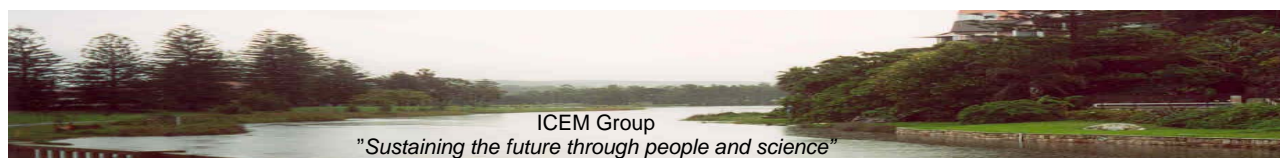
Aquatic habitats are also covered in the riparian assessment section.

Stakeholder Evaluation

Integrated catchment management places an emphasis on systems thinking and holistic and cooperative management and partnerships and this is reflected in goal 4 of the strategy. Evaluation of the efficacy of management needs to concentrate on the issues that are of greatest significance in encouraging the ICM process to function as a system rather than individual project activities.

Outcomes

- Continued influential participation of key stakeholders who have strategic capacity to support integrated decision making and share sustainable benefits;
- Improved targeting and cost effectiveness of activities to sustain the catchment's natural resources;
- An integrated monitoring framework that benchmarks catchment health, informs adaptive management needs, and effectively communicates relevant outcomes to all;
- Environmental improvements are gained in shorter timeframes;
- Improved co-ordination, co-operation and communication within and between Councils and Agencies;



- Planning, assessment, monitoring and review processes are standardised and accepted as part of management cycle;
- Cost savings through improved partnerships and effort and feedback to management from monitoring information; and
- Aboriginal representatives and other interest groups more involved with management and decision-making processes relating to cultural sites and heritage features.

Methods

SHEF, the Self-Help Evaluation Framework for Integrated Catchment Management is a system for evaluation of ICM programs. It was developed by the CSIRO Land and Water and is based on a checklist of issues considered important to ICM. SHEF is designed to encourage improvements in understanding and action and make progress much more evident in process terms rather than provide a quantitative score of relative achievement. While development of the framework has primarily been carried out in rural areas, it is also applicable to Manly Lagoon catchment.

The framework is designed for stakeholders to use on an individual basis or in groups. However, the scale of the Manly Lagoon and Catchment ICM Strategy is such that a facilitated group process would be the most effective.

The SHEF framework addresses each of the outcomes above either directly or indirectly. The full documentation can be accessed from the Land and Water Australia Internet site at <http://www.lwa.gov.au/about.asp?section=140>

Council data

Information for the following indicators is likely to be already available from councils or could be easily collected:

- Number of community members involved in restoration, monitoring and education actions;
- Percentage of heritage features lost or damaged;
- Number of groups involved in rehabilitation and management; and
- Use of chemicals and toxic substances to control weeds and pests.

