# Great Lakes Water Quality Improvement, lessons for coastal catchments

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## Introduction

Great Lakes Council is implementing a sustainable estuary and catchment management program for Wallis, Smiths and Myall Lakes. The centre piece of Council's successful program is the Great Lakes Water Quality Improvement Plan. This paper showcases the plan, demonstrating how the latest catchment and estuary scientific research, modelling and best practice recommendations have been integrated into local level planning and management. The knowledge and procedures generated from this project are in the main, directly transferable to other coastal catchments.

Research from the Water Quality Improvement Plan identified areas where nutrient loads need to be capped and other areas where rehabilitation is required. The plan established ecological condition targets. These targets are the basis for determining the magnitude and nature of the rehabilitation and protection required to meet the communities expectations in relation to estuary health.

As a result of the Water Quality Improvement Plan, Great Lakes Council have an integrated approach to managing water quality in urban areas including policies to manage re-development and re-zoning as well as a commitment to improving water quality from urban areas. This paper uses case studies to demonstrate how water quality objectives have been translated into policy and on ground action, these will include:

- Rehabilitating degraded areas of Wallis Lake by retrofitting urban areas with Water Sensitive Urban Design structures
- The process Great Lakes Council uses to protect water quality when re-zoning land - including implementing a 'no net increase' target for Greenfield development
- Development and implementation of a water sensitive development control plan for re-developments to achieve water quality improvements and
- The approach used to improve Councils management practices that impact on water quality.

The overall approach to water quality planning, community and stakeholder engagement and scientific modelling used to develop the Water Quality Improvement Plan is applicable across landscapes with sensitive receiving water bodies.

## Establishing a Scientific basis for water quality objectives

In September 2005, the Australian Government provided funding to Great Lakes Council through the Coastal Catchments Initiative (CCI) to undertake research to develop the Great Lakes Water Quality Improvement Plan for Wallis, Smiths and Myall Lakes (Figure 1). The aims of the project were to:

- identify the specific levels of nutrients and sediments that are required to provide conditions for a healthy lake ecology and environmental values desired by the community,
- identify the best way to manage activities to reduce key pollutant loads entering the lakes
- review pollution control and faecal coliform management systems as they relate to the management and protection of the lakes.

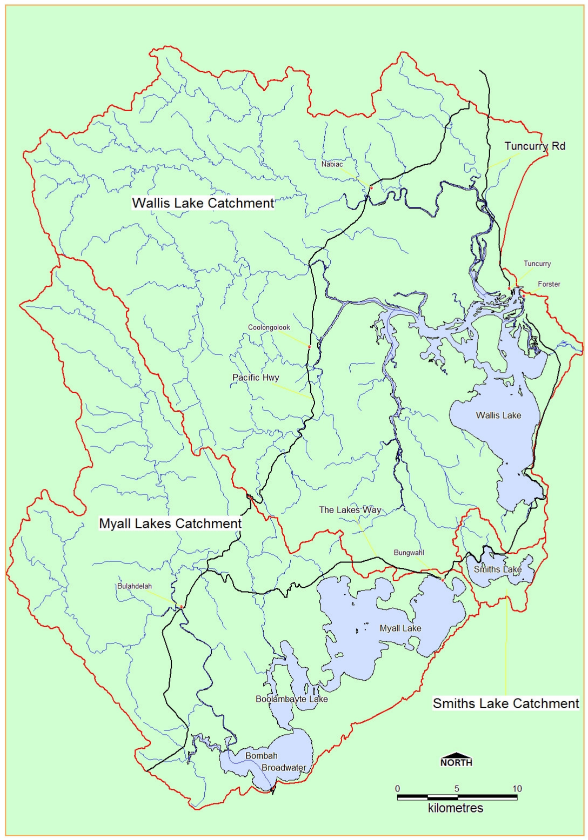



**Figure 1: Catchment area included in the Great Lakes Coastal Catchments Initiative**

The Water Quality Improvement plan draws on new research, modelling and community engagement to identify a range of rehabilitation, protection and management support actions to protect and support (and where required, restore) the ecological health of these systems.

Research and modeling undertaken by the Coastal Waters Unit, Department of Environment, Climate Change and Water (DECCW) was used to develop an understanding of the 'current condition' of the lakes. Using water clarity (turbidity) and Chlorophyll-a (amount of phytoplankton) as indicators of ecological condition, the research identified areas of the lakes that fell into one of three categories:

- High conservation value
- Moderately disturbed and
- Heavily impacted.

In Wallis Lake, ecological condition ranged from high conservation value at the southern end of the lake to a moderately disturbed ecosystem in Pipers Creek and Pipers Bay.

The southern end of Wallis Lake is currently in a near pristine state supporting a wide variety of seagrass, sea sponges, healthy algae and brackish water plants to depths of greater than three metres.

Pipers Creek and Bay are the receiving waters from the medium density urban and light industrial developments of Forster. Chlorophyll-a concentrations in this area were among the highest measured anywhere in the system the average value for Pipers Creek was five to six times greater than values expected for this type of environment.

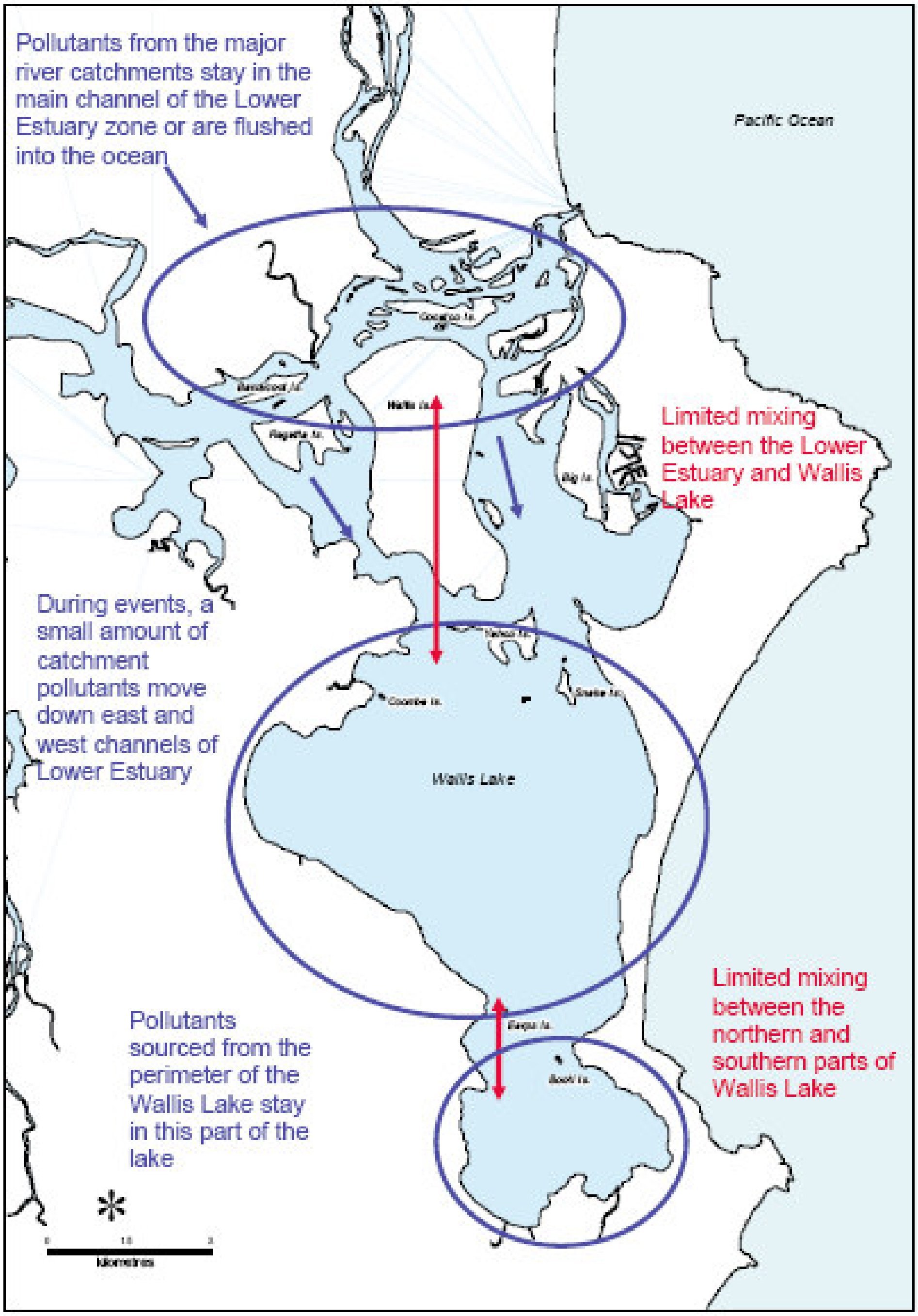
DECCW developed a hydrodynamic model which was used to describe how pollutants from sub catchment groups mix and are moved throughout Wallis Lake. As summarised by Figure 2, the modeling shows that the entrance / lower estuary and Wallis Lake largely operate as two non-interactive water bodies. Pollutants from the major river catchments that are transported to the lower estuary during floods generally stay within the main channel to the north of Wallis Island, with only a very small amount moving down the east of west channels. During large rainfall events, a plume of pollutants from Pipers Creek and Pipers Bay travel south along the eastern shores of the lake into the high conservation area of southern Wallis Lake.

Based on the hydrodynamic modeling, ecological condition targets were established for different sections of Wallis Lake including Wallis Lake (southern Wallis Lake and Coomba Bay), Pipers Bay, entrance / lower estuary, middle and upper river estuary. As an example, the ecological condition target for Pipers Bay is to manage the catchments to improve its current modified condition to more closely resemble high conservation value. To achieve this level of improvement the aspirational target for Pipers Bay is to reduce Chlorophyll-a concentrations by 50%.

The research undertaken to develop this plan goes beyond what has been previously achieved in catchment and estuary planning. Using catchment and ecological response models we were able to establish a quantifiable link between changes in catchment management, the resulting changes in sediment and nutrient loads and the consequential ecological response of the estuary. For Pipers Bay, management actions identified for the life of the Water Quality Improvement Plan (7 years) were modeled as achieving a 14% reduction in Chlorophyll-a, well short of the identified aspirational target of 50% reduction.

The analysis undertaken to develop the Water Quality Improvement Plan highlighted the importance of protecting the lake against further deterioration. Remediation is very costly, time consuming and often limited in what can be achieved. Protection of areas of existing high conservation value (such as the southern end of Wallis Lake) is extremely important as the limitations of remediation are such that any damage to these areas is likely to be irreversible and therefore unacceptable to the community.

The results of this research established a defensible platform for planning decisions and policies based on the latest scientific findings. Through extensive engagement with the community during plan development, the results of these investigations clearly demonstrated the challenges associated with achieving community expectations in relation to estuary health. The research and modelling effectively established a 'business case' for the actions outlined in the Water Quality Improvement Plan and political support for its implementation.




* Exert from the Great Lakes Water Quality Improvement Plan (2009), summary diagram based on modelling outputs from the Coastal Waters Unit, Department of Environment, Climate Change and Water

**Figure 2. Summary of hydrodynamic modelling results, Wallis Lake**

## Translating Ecological Condition Targets to Policy and Action in Urban Areas

Given the scale of the problem identified for Pipers Bay and the potential for this area to impact on high conservation value areas of Wallis Lake, the Water Quality Improvement Plan outlined a comprehensive, multi faceted approach to address water quality in existing and future urban developments including:

- Management of water quality impacts from small and large scale development through the application of Water Sensitive Urban Design principals
- Retrofitting the catchment with Water Sensitive Urban Design devices and
- Education and capacity building program on Water Sensitive Urban Design including improvements in sediment and erosion control practices.

Examples of the way that Great Lakes Council are translating the ecological condition targets to policy and action are outlined in the following sections.

### *Management of water quality impacts from small and large scale development*

To translate the ecological condition targets to policy, Great Lakes Council have drafted a water sensitive design development control plan. Based on the strategic direction set out in the Water Quality Improvement Plan the DCP addresses both the protection and rehabilitation of catchments in urban areas.

*Greenfield Sites*

For re-zoning and Greenfields developments the DCP sets the objective 'no net increase' in nutrients, protecting the receiving waters from any further degradation. For rural and forested sites, stormwater modelling will be used to estimate current site performance, and the modelled performance will be the target for urban and dense rural residential development (Table 1).

When the rezoning process commences for land in catchments that discharge into sensitive receiving waters, developers are required to demonstrate how they will achieve identified water quality targets (i.e. no net increase in nutrients). To achieve this target, developers and Council staff undertake a staged process of negotiation. The outcome of this process will be a Masterplan / DCP for the site, which prescribes the WSUD facilities needed to achieve the identified water quality targets, and / or a Voluntary Planning Agreement under the *Environmental Planning and Assessment Act 1979*.

The staged process is outlined as follows:

*Stage 1 – agree baseline condition*: The first stage in rezoning Greenfield sites is to agree the 'baseline' condition with the developers; the baseline condition is the basis for the site-specific targets that developers are required to meet on their site (e.g. percentage of forested land to rural land in the release area).

*Stage 2 – identify site specific targets*: Using the baseline condition identified in Stage 1, urban stormwater modelling (MUSIC) is used to determine the nutrient loads from the undeveloped site.

*Stage 3 – identify Water Sensitive Urban Design (WSUD) treatments:* Using urban stormwater modelling, developers then undergo a process of identifying appropriate WSUD treatments to achieve their targets that inform the DCP / Masterplan. It is at this stage of the negotiations that developers also engage with MidCoast Water to discuss potable supply, wastewater management and reuse of water on their site. This may result in an overall integrated water cycle management strategy being prepared.

*Stage 4 – peer review:* Using the information derived from Stages 1 and 2, the developers then prepare a Water Management Strategy that identifies the WSUD devices that are to be used to treat urban runoff from their development. To ensure that the water quality outcomes will be achieved, the developers then fund a review of their Water Quality Management Strategy by independent consultants engaged by Great Lakes Council. Negotiations with GLC staff and consultants occur at this stage to finalise the content of the DCP / Masterplan for the site and the extent to which it incorporates the outcomes of the final Council-endorsed Water Management Strategy.

*Stage 5 – negotiations on a VPA*. To ensure that there is commitment to the installation of the water quality management facilities identified in the DCP / Masterplan, Council and the developer may negotiate a VPA so as to ensure these facilities, or alternatives that will achieve the same water quality result, are delivered at the development stage. The VPA may also include a commitment by the developer to fund the ongoing maintenance of the water quality management facilities so that any significant financial liability for the ongoing maintenance is not borne by Council.

*Stage 6 – submit a DCP / Masterplan:* Once the DCP / Masterplan, and if applicable VPA, is agreed with Great Lakes Council staff, the plan is presented to Council for approval and the land is rezoned for future development.

*Stage 7 – site development:* When the developers are ready to develop their site, they then submit a Development Application, which is assessed against the DCP / Masterplan established. Further detailed negotiation occurs with the developers at this stage.

*Re-development*

For re-developments, the objectives are aligned with DECCW water quality targets described in Table 1 as best practice load-based reduction targets (Total Nitrogen 45%, Total Phosphorus 60%, Total Suspended Solids 80%). In the case of re-development, achieving these targets will result in an improvement in water quality contributing to the rehabilitation of the catchment.

For small re-developments such as major renovations to single dwellings, single lot subdivisions into two and small townhouse developments (less than four lots or 2000 metres square) the DCP will provide WSUD design recipes that have been generated from MUSIC modelling. These will constitute the deemed to comply section of the DCP and include WSUD features such as rainwater tanks with overflow pits and small bioretention systems. Applicants also have the option to undertake MUSIC modelling and design of an alternative system if they do not wish to use the deemed to comply option.

For larger redevelopments, the DCP provides the opportunity for developers to meet the identified performance standards (Total Nitrogen 45%, Total Phosphorus 60%, Total Suspended Solids 80%). In these situations, steps three and four described for re-zoning apply.

While Great Lakes Council have not yet adopted the Water Sensitive Development DCP, negotiations with developers on re-zonings and large re-developments have occurred over the past three years and have been successful in negotiating water quality outcomes for the lakes.

**Table 1: Targets for urban and dense rural residential land development**

| **Land development matrix** | | | **Kind of development** | | | |
|---|---|---|---|---|---|---|
| | | | *No redevelopment* | *New urban development* | *New dense rural residential development* | *Construction site* |
| | *Rural land and forest* | | *(see rural strategy)* | • No net increase | • No net increase | • CRCCH targets [a] |
| | *Large lot rural residential* | | *(see rural strategy)* | • No net increase | • No net increase | • CRCCH targets |
| **Starting from** | *Dense rural residential* | | • Gradual improvements through road reconstruction, education, etc. | • No net increase | • No net increase | • CRCCH targets |
| | *Established urban* | *General case* | • Gradual improvements through road reconstruction, education, etc. | • Best practice load-based reduction targets | *(does not occur)* | • CRCCH targets |
| | | *Buladelah and other towns in the catchment of the Myall Lakes* | • Gradual improvements through road reconstruction, education, etc. | • Best practice load-based reduction targets urban areas, or no net increase, whichever is more demanding [b] | *(does not occur)* | • CRCCH targets |
| | | *Catchment of Pipers Creek and Pipers Bay* | • Improvements from Pipers Creek catchment retrofitting program<br>• Gradual improvements through road reconstruction, education, etc. | • Best practice load-based reduction targets [c] | *(does not occur)* | • CRCCH targets |

a: These targets derive from Taylor (2002). CRCCH targets for construction sites, 60–85% reduction in total suspended solids
b: In the Myall Lakes, tidal exchange occurs slowly, so urban development needs to be undertaken with particular care, given their importance as Ramsar wetlands.
c: A significant improvement on 'no net increase' in these locations, given the development history.

***Retrofitting the catchment with Water Sensitive Urban Design devices***

To address the significant water quality issues identified in Pipers Bay, the Pipers Creek and Bay Catchments have become the focus for an urban retrofit program involving the installation of Water Sensitive Urban Design devices. To develop the Water Quality Improvement Plan, urban stormwater modelling (MUSIC) was used to estimate the nutrient load reductions that could be achieved by retrofitting the catchment.

To initiate the implementation phase, more detailed analysis of opportunities for retrofitting was undertaken, WSUD devices identified were prioritised based on value for money (cost and ability to remove nutrients). A project management team comprising of staff from Engineering (design and investigation, transport assets and operations) and Planning (Natural Systems) was formed to guide the project into design and construction. During site selection many constraints such as elevation, access, and ground water levels that had not been identified in the modelling phase were identified on closer field based inspection. A site located in a drainage reserve in the Pipers Creek Catchment was selected to have five bio-retention systems constructed.

Early in project development, the project management team identified the local mowing group as key stakeholders. Meetings with the residents highlighted a number of design and maintenance issues that were investigated further by Council and later considered in the detailed designs. Despite the efforts made to address concerns raised, a small number of residents continue to have reservations regarding the installation of the devices. The majority were accepting and understanding of the need and operation of the new devices. The lesson learnt is that that new technology will not be embraced by all but effective community engagement is essential to establish broad support. Despite one or two complaints this project has not entered into the political arena.

The physical and social constraints demonstrated in this example highlight the difficulties associated with retrofitting existing urban areas with WSUD. Furthermore, experience with this initial project suggests that the costs associated with such a program will far exceed the costs identified in the strategic Water Quality Improvement Planning phase. Great Lakes Councils initial experience with implementing the Pipers retrofit program highlights the importance of integrating WSUD into new developments to protect water quality and using re-developments as an opportunity to rehabilitate.

***Education and capacity building program on Water Sensitive Urban Design***

Discussions with stakeholders during the development of the Water Quality Improvement Plan identified compliance with sediment and erosion control policies as a major risk in relation to water quality management. Unmanaged erosion from construction sites release pollutants into waterways at a rate two orders of magnitude higher than bushland.

Great Lakes Council have initiated a project with Greater Taree City Council and MidCoast Water to review and improve water quality policies, procedures and compliance. The project will focus on sediment and erosion control practices and involve:

- Reviewing exiting policies and procedures to ensure that they meet best practice and are consistent with other water quality management policies

- Improving compliance with sediment and erosion control policies while building staff capacity to improve performance in this area through the adoption of an internal auditing system
- Raising awareness of the importance of sediment and erosion control
- Developing systems and processes that will result in improved sediment and erosion control

While this project is in its early stages, the planning phase has been approached in a way that will set the project up to build the capacity of staff within each of the partnering organisations. It is hoped that by engaging staff at the higher end of the public participation spectrum (involve, collaborate, empower) that support for the project and its activities will result in improvements in sediment and erosion control practices and compliance.

## Key Lessons Learnt

The lessons learnt by Great Lakes Council by developing and initiating the implementation of the Water Quality Improvement Plan can be in the main applied to coastal catchments and areas where catchments flow into sensitive water bodies. In summary, water quality improvement programs should be multifaceted and:

- Be based on sound scientific data in order to identify where to target resources for rehabilitation and establish political and community support for water quality improvement activities
- Involve people in the planning process, don't underestimate the knowledge or support that can be given by approaching issue together (including developers, the community and industry groups)
- Recognise the importance of addressing both protection and remediation actions
- Address water quality issues at their source through capacity building programs that involve a wide range of stakeholders including the general community, council's outdoor staff, builders and developers
- Utilise all mechanisms available to improve water quality including the planning framework, capacity building programs and on ground works projects
- Maximise water quality protection and rehabilitation opportunities by addressing water quality issues at a range of scales (eg small re-developments and greenfields development)
- Set stringent 'no net increase' objectives for Greenfield sites in sensitive and or poorly flushed receiving water bodies as the DECCW water quality targets (TN 45%, TP 60%, TSS 80% and GP 90%) allow for an increase in pollutants
- Ensure that the DECCW water quality targets are applied to all re-developments
- Avoid using DECCW water quality targets for Greenfield development as it is generally not desirable to increase nutrient loads.

From Great Lakes Councils experience, some of the lessons learnt in implementing the water quality improvement program are:

- When retrofitting an urban area with WSUD devices (particularly in low lying coastal areas) there are many constraints on where they can be located, strategic planning may overestimate the potential retrofit program
- Costs of implementing the bio-retention systems exceeded initial estimates, strategic planning may underestimate the costs - contingencies are required

- Establishing cross council project management teams to undertake urban retrofit programs is crucial to their success
- Involving nearby residents in the early stages of planning for WSUD devices can assist with managing potential concerns and avoid the project entering the political arena
- Accept that despite the best engagement processes it may not be possible to have universal support for WSUD devices
- It is possible to achieve 'no net increase' on Greenfield sites and developers are prepared to contribute towards peer review of stormwater models
- Introduce a stormwater levy and allocate at least 50% to water quality projects including maintenance of new facilities

## Acknowledgements

This paper includes exerts from the Great Lakes Water Quality Improvement Plan, authors of the plan are acknowledged

The scientific findings described in this paper summarise the research undertaken by the Department of Environment, Climate Change and Water's Coastal Waters Unit

### References

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