SOUTH EAST QUEENSLAND
HEALTHY WATERWAYS
PARTNERSHIP

Constructed Waterbodies in Urban Areas of South East Queensland: Maintenance Issues and Costs to Local Government

Version 1.0, 27 August 2007

A Discussion Paper prepared by the South East Queensland Healthy Waterways Partnership on behalf of Local Government Partners.

Executive Summary

Constructed waterbodies are a popular feature of urban development in South East Queensland (SEQ). However, anecdotal reports from local government officers within SEQ indicate that many of these waterbodies regularly fail to meet their design water quality objectives. This often results in poor ecological function and the degradation of the waterbody. The costs to prevent such problems and/or restore degraded systems are thought to be substantial, but are not well documented in the SEQ region.

This brief discussion paper summarises data on water quality and maintenance costs for constructed water bodies under the ownership of local government in urban areas of SEQ. The data was collected in late 2006 through a survey of SEQ local governments, initiated by the South East Queensland Healthy Waterways Partnership. Responses from 6 of the 18 local governments in the region provided data on 83 urban waterbodies with a combined total surface area exceeding 490 ha.

Nutrient concentrations in existing waterbodies were found to exceed relevant water quality objectives, particularly for phosphorus. This resulted in elevated algal biomass and prolific macrophyte growth in many of the waterbodies.

In the 2005/06 financial year, three of the surveyed councils spent an estimated total of nearly $4.8 million on maintenance activities for 20 constructed urban waterbodies. About two-thirds of this amount was spent on routine maintenance and the remainder on corrective maintenance required to restore deteriorated or malfunctioning components of a waterbody. Management of aquatic vegetation was identified as the most significant routine maintenance cost.

The available data, though limited, provides an indicative routine maintenance cost of the order of $11,000 per ha per year for constructed waterbodies. Applying this indicative unit rate across all waterbodies represented in the survey, the total annual cost of routine maintenance is over $5 million. Corrective maintenance activities are a significant additional cost. Since most waterbodies do not meet relevant water quality objectives, it is likely that this underestimates the full cost that would be required to maintain waterbodies at an acceptable water quality standard in the long term.

The findings of this investigation show that management of constructed urban water bodies in South East Queensland is a significant environmental and financial issue for local government.

1.0 Introduction

Constructed urban waterbodies (commonly referred to as 'lakes') are a popular feature of urban development in South East Queensland (SEQ). Such waterbodies may be created for a variety of social, economic and environmental reasons. From the perspective of land developers, urban waterbodies can provide scenic amenity as well as recreational opportunities and wildlife habitat, which commonly lead to higher land values in surrounding areas. In addition, the excavation of waterbodies can provide valuable fill material in low-lying areas.

Whilst constructed urban waterbodies may confer many benefits upon their local communities, the long-term management of these systems presents a number of challenges to local government, which has often taken over responsibility for these systems after establishment. Anecdotal evidence from local government officers in SEQ indicates that maintenance of acceptable water quality is one of the key management issues for urban waterbodies in the region. However, to date, very limited information has been available to characterise the observed water quality in the region's urban waterbodies, or to provide an estimate of the most likely maintenance requirements and costs.

This discussion paper presents the findings of an investigation into the water quality and maintenance costs of urban waterbodies, based on data supplied by local government in SEQ. The paper also recommends a number of actions to facilitate improved understanding and management of urban waterbodies in SEQ and reduce maintenance costs for local government.

2.0 Overview of Water Quality Issues

One of the key differences between urban waterbodies and those in rural areas (such as water supply dams) is the water quality of inflows. Urban activities, such as the use of fertilisers and imported soils, commonly increase the available nutrients within a catchment, which can then be efficiently transported through the urban drainage system. Hence, urban stormwater inflows to a waterbody typically contain elevated nutrient concentrations (especially nitrogen and phosphorus) compared to runoff from non-urban areas. This elevated supply of nutrients to a waterbody may result in:

- excessive algal growth,
- cyanobacteria blooms, and
- excessive growth of nuisance vegetation.

The subtropical climate of SEQ has some specific characteristics that further increase the risk of water quality problems within storages that collect urban stormwater runoff. These characteristics include:

- Relatively high temperatures that increase biological productivity. Over an annual cycle, restricted productivity due to low temperature is almost non-existent.
- High inflow variability due to the seasonality of rainfall and the occurrence of high-intensity storms with substantial inter-event periods. Under these conditions, impounded water is not regularly flushed, potentially resulting in the depletion of dissolved oxygen through algal and bacterial processes.

Figures 1 and 2 illustrate the potential effects of these processes on urban waterbodies in SEQ.

Figure 1 Excessive macrophyte growth in an urban waterbody

Figure 2 Algal bloom in an urban waterbody

3.0 Collection of Data on Urban Waterbodies in South East Queensland

In October 2006, a project steering committee of local government representatives, hosted by the South East Queensland Healthy Waterways Partnership, initiated a survey of local governments in SEQ to obtain information on:

- The number and physical characteristics of urban waterbodies within their jurisdiction,
- Observed water quality within these waterbodies,
- Actual or estimated expenditure on maintenance activities for these waterbodies.

To focus the study on major urban water features, data was requested only for waterbodies with a surface area of greater than 0.5 ha (5,000 m^2) and substantially urbanised catchments. This eliminated water supply dams and most stormwater treatment devices (such as sedimentation basins and constructed wetlands) as well as a very large number of small impoundments, such as golf course ponds and in-stream pools, from the investigation. Tidal systems were not included in the study.

Using these criteria, data was obtained on 83 waterbodies across 7 of the 18 local government areas in SEQ. The median surface area of these waterbodies is 2.2 ha, with a combined total surface area exceeding 490 ha. It is noted that this is unlikely to represent all of the waterbodies in the region under the control of local government, since some local governments had minimal data on relevant waterbodies, or inadequate resources to respond to the data request.

4.0 Observed Water Quality

A summary of available water quality data for the region's urban waterbodies (Table 1) indicates that:

- Excess turbidity is not a major issue for most of the region's waterbodies. Recorded turbidity levels are generally within the range of guideline values.
- Typical nutrient concentrations (nitrogen and phosphorus) are much higher than guideline values.
- Phytoplankton biomass (as measured using Chlorophyll *a*) is always above the guideline value.

These results confirm the opinion of local government officers that poor water quality is a key management issue for the region's existing urban waterbodies.

Table 1: Summary of water quality data of identified waterbodies.

	No. waterbodies with data	Total no. of samples	Min.	Median	Max.	Guideline Value *
Turbidity (NTU)	9	333	0.9	3.3	27.3	1 - 20
Total Nitrogen (mg L^{-1})	13	545	0.34	0.55	3.25	0.35
Total Phosphorus (mg L^{-1})	28	545	0.01	0.10	0.34	0.01
Chlorophyll *a* (µg L^{-1})	7	275	6	10	50	5

* Regional guidelines for physico-chemical parameters in lakes and reservoirs in South East Queensland (Table 2.5.1.1, EPA 2006).

5.0 Maintenance Activities and Costs

Maintenance cost data was provided for 20 of the 83 waterbodies identified in the survey. Data on maintenance activities and costs was supplied by Brisbane City, Maroochy Shire and Gold Coast City Councils. One of the difficulties encountered by local government officers in collating relevant data was that maintenance costs are often tracked against activities or regions, rather than against a specific waterbody.

Maintenance activities for urban waterbodies can be divided into **routine maintenance** and **corrective maintenance**. Routine maintenance consists of regular tasks or expenses necessary to operate and maintain an acceptable level of functionality of the system. For example, vegetation harvesting, cleaning of pre-treatment devices or running costs for an artificial recirculation system. These are costs that can be anticipated on a regular cycle.

Corrective maintenance includes works required to restore deteriorated or malfunctioning components of the system. For example, repair of revetment walls or installation of an in-situ treatment system. These costs are more difficult to estimate and can often involve substantial expenditure.

In the 2005/06 financial year, Brisbane City, Maroochy Shire and Gold Coast City spent an estimated total of nearly $4.8 million on maintenance activities for constructed urban waterbodies. Almost two-thirds of this amount was spent on routine maintenance (such as vegetation harvesting and cleaning of pre-treatment devices) and the remainder on corrective maintenance required to restore deteriorated or malfunctioning components of the system. Management of aquatic vegetation was identified as the most significant routine maintenance cost.

The available data (though limited) provides an indicative routine maintenance cost of the order of $11,000 per ha per year for constructed waterbodies (see Table 2). Applying this indicative unit rate across all waterbodies in the region, the total annual cost of routine maintenance is of the order of $5.4 million. Corrective maintenance activities are a significant additional cost. Since most waterbodies do not meet relevant water quality objectives, it is likely that this underestimates the full cost that would be required to maintain waterbodies at an acceptable water quality standard in the long term.

Table 2: Summary of total routine and corrective maintenance costs for 20 urban waterbodies within SEQ during 2005/06.

Maintenance Type	Total Cost ($)	Cost per ha Surface Area ($)
Routine maintenance	$3,025,000	$11,300
Corrective maintenance	$1,730,000	$6,500
Total (Routine & corrective maintenance)	$4,755,000	$17,800

Note: Total surface area of costed waterbodies = 268 ha.

6.0 Conclusions

Data provided by SEQ councils indicates that local government in this region is responsible for the maintenance of at least 83 major constructed urban waterbodies. This does not include the large number of smaller water bodies (less than 0.5 ha) which were excluded from the study. The median surface area of waterbodies identifed in the survey was 2.2 ha, with a combined total surface area exceeding 490 ha.

Representative nutrient concentrations in urban waterbodies across the region substantially exceed guideline values for a range of water quality parameters. This increases the risk of a range of water quality and other environmental problems, such as algal blooms and excessive macrophyte growth.

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The data collected during this study provides some insight into the magnitude of maintenance issues associated with constructed urban waterbodies, as well as key areas of research and management action to improve system performance and reduce maintenance costs in the long term. Key research and management issues that can be inferred from the results of the study include the need for:

- Ongoing research to improve the understanding of nutrient cycling processes and limnological behaviour of typical urban waterbodies under local conditions. The USEPA are currently undertaking such a research program in the USA (the "National Lakes Inventory", USEPA 2007).

- Development of reliable remediation strategies for eutrophic systems. Waterbody remediation guidelines would provide an increased level of confidence that a proposed remediation strategy would achieve a defined level of improvement in water quality at minimum cost.

- Development of locally-relevant design and maintenance guidelines for urban waterbodies. These guidelines would ensure that any new systems are designed, constructed and maintained to prevent eutrophication.

- Wider dissemination of learnings between different local governments. Some of the work that has been undertaken by councils in studying and developing management plans for their constructed water bodies should be shared with others across the region.

- Development of a regionally consistent water quality monitoring program for constructed urban water bodies to ensure that data is collected with similar frequency and analysed using consistent methods across the different local government areas.

- Implementation of a regionally consistent protocol for collection of data on maintenance activities and costs for constructed urban waterbodies. The data generated through this process would improve the ability of local government to plan the allocation of maintenance resources.

- Local government to consider options to ensure that a financially sustainable management regime is implemented for any proposed new urban waterbodies.

References

EPA (2006). *Queensland Water Quality Guidelines*. Queensland Government Environmental Protection Agency, March 2006.