

Prioritisation and Decision Support for Urban Stream Management

**Robert Mezzatesta - Manager, Tweed Region, Eco Logical Australia,
Murwillumbah, Australia**

**Peter Morison - Waterways Systems Manager, Parramatta City Council,
Parramatta, Australia**

Andrew Morison - Director, Eco Logical Australia, Sutherland, Australia

**James Carey - Environmental Outcomes Manager, Parramatta City Council,
Parramatta, Australia**

Abstract

Urban waterways are subjected to multiple uses and expectations by the community. Prioritising urban waterways to appropriately manage the conflicting uses and expectations is fundamental to urban natural resource management. A multi-disciplinary team developed a process using an ecological, social and economic assessment for prioritising waterways within the urban catchments of the Parramatta Local Government Area. The team devised a tool that is designed to direct the application of valuable resources where they are needed most. The process includes the collaborative definition of a set of quantifiable criteria that broadly categorises the nature of the Parramatta waterways incorporating social, economic and ecological values; identifies specific goals and targets to be met for different parts of the Parramatta waterways; and prioritises the waterway reaches for management and action using a GIS analysis. An interactive management tool has been developed for a manager to quickly and easily develop "what if" scenarios at a reach scale to test the results of future development options and population growth, scope the effects of future management actions over long term planning periods and evaluate the effectiveness of approved management actions in a regional context.

Background

There are several methods that have been developed which classify our rivers. These are often based on one or more of the following: Stream health (chemical and biological aspects); geomorphic processes; and hydrological characteristics.

While these methods provide important information, they alone are often inadequate in terms of allocation of resources or works, in particular where there are limited budgets available. Further, they are generally not relevant to urban waterways.

Often social, political and economic factors are the main drivers behind the prioritisation and allocation of resources to stream management. These are generally not incorporated into any formal assessment processes.

Unfortunately many of the prioritisation schemes are also driven at a national level resulting in urban streams being classified together with rural or peri-urban streams. As a result, the current schemes provide little guidance to local councils, who are responsible for the management of waterways in greater metropolitan Sydney.

For a council to develop a community and politically acceptable approach to the allocation of resources, a prioritisation process must incorporate not only the ecological priorities but also the social and economic factors. This Triple Bottom Line approach recognises and embraces the need to balance ecological and human needs for a river or stream, particularly in an urban context.

Centrally located in the Sydney basin, the City of Parramatta provides for an expanding urban population that has broad cultural influences and a variety of needs revolving around the waterways that pass through the area.

The City possesses 65 km of natural streams and an additional 13 km of open channels. The quality of the streams vary greatly from highly modified drainage channels to highly natural creeks that are well endowed with natural life and surrounded by significant stands of native vegetation. The area includes four separate catchments that drain into Sydney Harbour.

As catchment managers, Parramatta City Council expends approximately \$1 million per annum on waterways rehabilitation and protection. But in its ambition to responsibly resource the conservation and improvement of its waterways, the Council reviewed the gamut of prioritisation methods and established a clear need to develop a system that is flexible, simple to operate and understand but rigorous in its apportionment of management priority on a reach-by-reach basis.

Project Aims

The main goal of the study was to develop an ecological, social and economic assessment of the City of Parramatta's waterways to allow for the allocation of scarce resources to meet the targets for a specific waterway. By applying a pragmatic approach that incorporates the principles underpinned by the Rehabilitation Manual for Australian Streams (Rutherford, Jerie & Marsh, 2000), the methodology shall be consistent and practical. The assessment and resulting process was then be used to provide clear direction for the prioritisation of works and plans within the City.

Specific objectives set out by Council for the project are:

- To develop a set of criteria to categorise the Parramatta waterways incorporating social, economic and ecological values.
- To identify specific goals and targets for different parts of the Parramatta waterways
- To prioritise the waterway reaches for management and action

Approach

A consultative approach was taken to develop the prioritisation process; this considered the following key factors:

- **Multidisciplinary** – a multidisciplinary team was selected to allow a broad range of skills and issues to be addressed, including ecologists, catchment managers, economists, social scientists and spatial scientists
- **Think tank** – an initial “think tank” discussion involved identified persons across a range of management responsibilities and backgrounds to formulate the approach to the project
- **Workshops** – a series of workshops were conducted with key Council staff to gather anecdotal information across ecological, economic and social issues and interpret initial findings from data analysis, as well as provide a mechanism for Council comment and involvement on the development of a prioritisation process

Methods

The framework to development of a prioritisation process includes a number of elements or principles. These principles can then be applied to the specific goals of the project. The key principles identified for the project are summarised below.

Objectives

- Identify the framework for the process and use strategic organisational objectives to guide the process

Criteria

- Definition of a suite of criteria that refine the broad objective and then derive a process to rank the overall values of the criteria relevant to the broad objectives

Indicators

- Identify the key information required as an indicator to measure each criteria value and develop a framework to combine these values to determine an overall score

Management Unit

- Develop an appropriate management unit as a base for the measurement of criteria and implementation of management actions

Category

- Categorize management unit related to the identified criteria scoring and ranking. Consider ecological, economic and social factors in this characterization

Targets/Goals

- Identify a set of broad targets that apply to the character of management unit

Recovery Potential

- Develop a scale and process to identify the likelihood of achieving targets for management units.
- Identify threats and risks for each management unit and develop a likelihood of success rating for targets, related to measurable data sets
- Combine the likelihood of success with risks to determine potential for the management unit
- Prioritise management units based on potential to achieve targets

These principles were applied to develop a framework for the prioritisation process into 4 major steps, shown in table 1 below. These steps guide a process that can be applied at various management levels depending on the amount of available information, and allow the development of a management hierarchy for decision making in the local government area.

Table 1 - Prioritisation Process

Step 1	Outcome
Management Units Definition of management unit boundaries within the Parramatta LGA, based on basic waterway reaches	Reaches within the Parramatta LGA are broken up into 47 discrete management units for analysis.
Step 2	Outcome
Management Unit Categorisation Determination of values, (ecological, social and economic), and goals of reaches through analysis of 8 identified criteria.	Management unit identified by calculation of each criteria value (H/M/L/VL) Development of management unit categories (1-4)
Step 3	Outcome
Risks/Threat Assessment Disturbance potential and level of threats/risks to achieving goals/targets for management units	Threat ranking, by management unit. Overall threat ranked H/M/L/VL
Step 4	Outcome
Prioritisation Overall ranking of waterway reaches based on the relationship between management unit category and identified threats	Identification of management units, in greatest need (urgency) of management action. Management units ranked from 1 (highest priority) – 16 (lowest priority).

The Process

Step 1 - Management Units

- 47 Management Units were identified within the Parramatta City (see figure 1)
- Management units were based on the main sub-catchments within the area
- Sub-catchments were sub-divided topographically where a waterway reach is complex

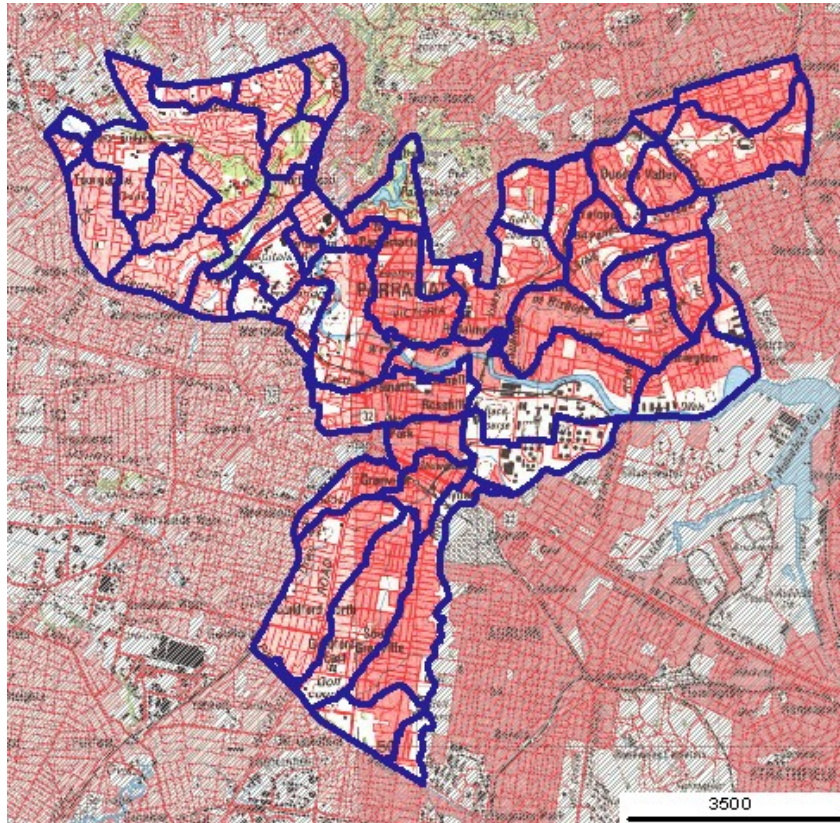


Figure 1 – Management unit subdivision in the Parramatta City Council area

Step 2 - Management Unit Category

A set of criteria were identified through a series of workshops. Information sources were then either collated or created for each of the criteria where possible. Consistent spatial information (GIS layers) was then allocated to each criterion for analysis. The criteria identified for this process to define a management unit were:

- River health -ability to support life
- Waterway stability - waterway dominated by natural ecological processes
- Land Status - Public security of land tenure, decreased development
- Vegetation - vegetation community and habitat quality
- Connectivity - ecological continuity and habitat value
- Heritage - cultural and historical significance
- Social values & significance - community significance
- Recreation - community significance and value

Descriptions of Management Unit Category

Following analysis of data an analytical scoring system was developed to rank each management unit according to a measurable degree of naturalness. The analysis consisted of:

- Definition of numeric values for each data set
 - data score by management unit
- Combine the score by criteria
 - criteria score by management unit
- Normalize waterway criteria score into High / Moderate / Low
 - degree of naturalness by management unit

The final criteria scores were then combined by management unit where:

- High Total Score = most natural category
- Low Total score = most modified category

The management units were then broken up into 4 major management unit groupings.

1. Natural significance – sensitive natural streams

Description	Generally high significance for vegetation, habitat and social values, low human impact
Goals	Protect existing biological integrity of the stream system and undertake steps to protect, maintain and enhance the high quality ecological values in the waterway
Targets	<p><i>Ecological</i> – a dynamic waterway (normal geomorphic dynamics) dominated by natural ecological processes (stable creek banks, no erosion featuring (stable) floodplain pockets (& flood channels) where they occur. Riparian vegetation is composed of native species with a 40-70% canopy closure, (dependant upon vegetation community), with a full linear connected corridor and lateral connections to other bushland.</p> <p><i>Social</i> – sensitive areas are protected from human disturbance. Signage is located at reserve entry points with low impact access to selected points.</p> <p><i>Economic</i> – all development adjoining the management unit addresses the ecological sensitivity of the waterway</p>

2. Natural significance multiple use – impacted streams

Description	Generally moderate to high significance for vegetation habitat and social value, moderate human impact
Goals	Protect existing biodiversity through focus on restoration and enhancement of ecological values. Restore to more “natural” stream dynamics
Targets	<p><i>Ecological</i> – a dynamic waterway dominated by natural ecological and geomorphological processes. Restore and expand the riparian corridor with native species. Establish at least a 50% corridor canopy with linear riparian connectivity.</p> <p><i>Social</i> – establish low impact access and use within some established and managed areas</p> <p><i>Economic</i> – all development adjoining the waterway to address their effect on its ecological values.</p>

3. Modified multiple use – degraded streams

Description	Generally moderate to low significance for vegetation habitat and social value, higher human impact, some modified channels
Goals	Main aim is minimal (lower priority) enhancement of habitat, protection and maintenance of infrastructure and reduction of pollution
Targets	<i>Ecological</i> - Stabilise eroded banks and establish riparian corridor with 25% canopy, removal of invasive species <i>Social</i> - Established waterway access and associated facilities <i>Economic</i> - Flood risk reduction measures implemented, adjoining development to address impact on public amenity

4. Modified – urban drainage

Description	Low or nil significance for vegetation habitat and social value, high human impact, modified channels, highly degraded waterways
Goals	Reduce pollutant levels, protect and maintain infrastructure, storm water management, and support flood protection in urban environment
Targets	<i>Ecological</i> - Established pollutant reduction program and works, management program for existing riparian vegetation <i>Social</i> - Enhanced waterway amenity, community open space <i>Economic</i> - Flood risk reduction measures implemented, adjoining development to address impact on public amenity and urban environment

Step 3 - Risks/Threat Assessments

A set of criteria were developed through a series of workshops using a similar process to the development of the management unit categories. Criteria for threats and risk were:

- **Land Status** - Identifies development, (degree of existing, potential for future, and level of encroachment). Presence of competition from invasive species, leading to habitat degradation
- **Public access** - Includes recreation pressure, opportunity for dumping and some pollution source. Safety issues
- **Natural Hazards** - flood risks, high frequency fire and acid sulphate soils

GIS data relating to each of the criteria was collated and analysed across the management units to develop a scoring system to determine risks and threats to success of the management unit categories.

Step 4 – Prioritisation

Prioritisation of management units is based on the ratio of benefit / effort resulting from an action. This is also influenced by relationships between the identified management unit category (degree of naturalness or modification) and the derived level of threat or risk for an area (impediment to achieving goals).

A number of generalisations may be made to define priority rankings for each of the management unit categories. These include:

Mapping Unit Category 1: Natural Significance – Sensitive Natural Streams

Management units of higher naturalness are likely to have higher general values (including economic and social values), than management units of lower naturalness, however:

- actions to improve the naturalness of such areas are likely to result in minimal total benefit;
- actions to prevent degradation of these areas are likely to have greater benefits given higher values are at stake.

Where threats have been defined as high or moderate in this category, the unit is given a high overall priority.

Mapping Unit Category 2: Natural Significance – Multiple Use Impacted Streams

Actions within this category may have high potential benefits given considerable tangible improvements in the values of the management unit may be achievable. Any areas with a high threat should be given a higher overall priority.

Mapping Unit Category 3: Modified Multiple Use – Degraded Streams

Actions within this category may also yield high potential benefits since there is normally considerable scope for improvement. Areas with a high threat rating should be given a higher overall priority.

Mapping Unit Category 4: Modified Areas – Urban Drainage

These management unit areas are highly unnatural. However, the importance of pollution, with its implications for downstream reaches, means that any category 4 areas given a high threat rating will have a moderate overall priority.

The relationship for each management unit is described in the following matrix (Table 2).

Table 2: Prioritisation Decision Matrix

	Management Unit Category	Threats			
		High	Moderate	Low	Very Low
More Natural	1	H	H	M	L
	2	H	M	M	L
	3	H	M	L	VL
Less Natural	4	M	L	VL	VL

H – High, M – Moderate, L – Low, VL – Very Low (lowest)

The relationship allows a ranking from 1 – 16, prioritising the need for action across each management unit. This ranking has been grouped into high (rank 1 - 4), moderate (rank 5 - 9), low (rank 10 - 13) or lowest (rank 14 – 16) priority. The rank value is maintained through the process.

This relationship is shown pictorially below in table 3

Table 3: Prioritisation Relationships

Management Priority Ranking	Priority Category (from decision matrix)
1	Highest Management Priority
2	
3	
4	
5	Moderate Management Priority
6	
7	
8	
9	
10	Low Management Priority
11	
12	
13	
14	Lowest Management Priority
15	
16	

Outcomes

Management framework

The process developed for prioritising waterways within the City of Parramatta provides a strategic management tool to direct the application of valuable resources where they are needed most. The resultant analysis prioritises a number of waterway reaches that should be targeted for appropriate management actions.

Whilst not recommending specific management actions, the tool provides a mechanism for a manager to quickly and easily develop scenarios for waterway reach management to:

- Test the results of future development options
- Scope the effects of future management actions over long term planning periods
- Evaluate the effectiveness of approved management actions in a regional context

Data

As part of the process a number of key spatial data sets were identified to support the prioritisation process. An important outcome of this process is the maintenance of the identified data sets to continue the effective use of the prioritisation tool and enhance the knowledge of the waterway reaches.

Priority Calculator

A management unit priority calculator was developed as part of this project to enable the manipulation of criteria scores by Council staff as more information about management units becomes available. The tool may be used:

- both with and without analytical data,
- to facilitate strategic “what if” scenarios, and
- to provide assistance in developing priorities for management actions on the in waterways of the City of Parramatta.

The calculator was designed to be simple to use and easily distributable. It is based on a Microsoft Excel workbook and incorporates steps 2 to 4 of the prioritisation methodology defined in Table 1.

Resultant data may be exported from the calculator and joined to a GIS data layer to visualise and classify the prioritisation results.

Applications for Council

Parramatta City Council has used the Methodology effectively in:

- prioritising the master-planning of its waterways;
- assigning appropriate riparian buffer widths;
- refining stream and floodplain management policy; and
- providing clear guidance in planning for future development.

As part the 'Rivers of Opportunity' strategy for waterways, Parramatta City Council has dedicated funds to prepare a master plan at a sub-catchment level that identifies the needs for the stream and recommends tangible actions for its rehabilitation. The Methodology provides a prioritised list of streams that will be master-planned over the next 10 years. To date, 3 master plans have been prepared and one is currently in preparation.

Parramatta is one of the 'River Cities' identified by the NSW Government for urban development and is planning for significant population growth over the next 30 years. The stream priorities have been used to influence the spread of denser urban development away from high priority streams.

A particular success of the approach was the input of a multi-disciplinary team from Council, specialists from government agencies and the specialist consultants. Not only did the team members learn much from each other, the rollout of the Methodology and its impact on planning for future development was efficient and effective as a number of the officers had been engaged.

It is important to note the data input and resultant priorities for streams shall be reviewed at least every 3 years as development and other pressures change and the rehabilitated streams improve in environmental, social and economic value. This is a resource-intensive exercise, as surveys are undertaken and data is reviewed.

Conclusion

The waterways prioritisation methodology is a cost-effective and practical tool for urban councils and waterways managers. Furthermore, the tool guides the scope and application of rehabilitation programs and influences the location and intensity of future urban development at a catchment scale.

References

Rutherford, I.D, Jerie K., & Marsh N (2000) *Rehabilitation Manual for Australian Streams Volume 1*. Cooperative Research Centre for Catchment Hydrology. Land and Water Resources Research and Development Corporation. Canberra.