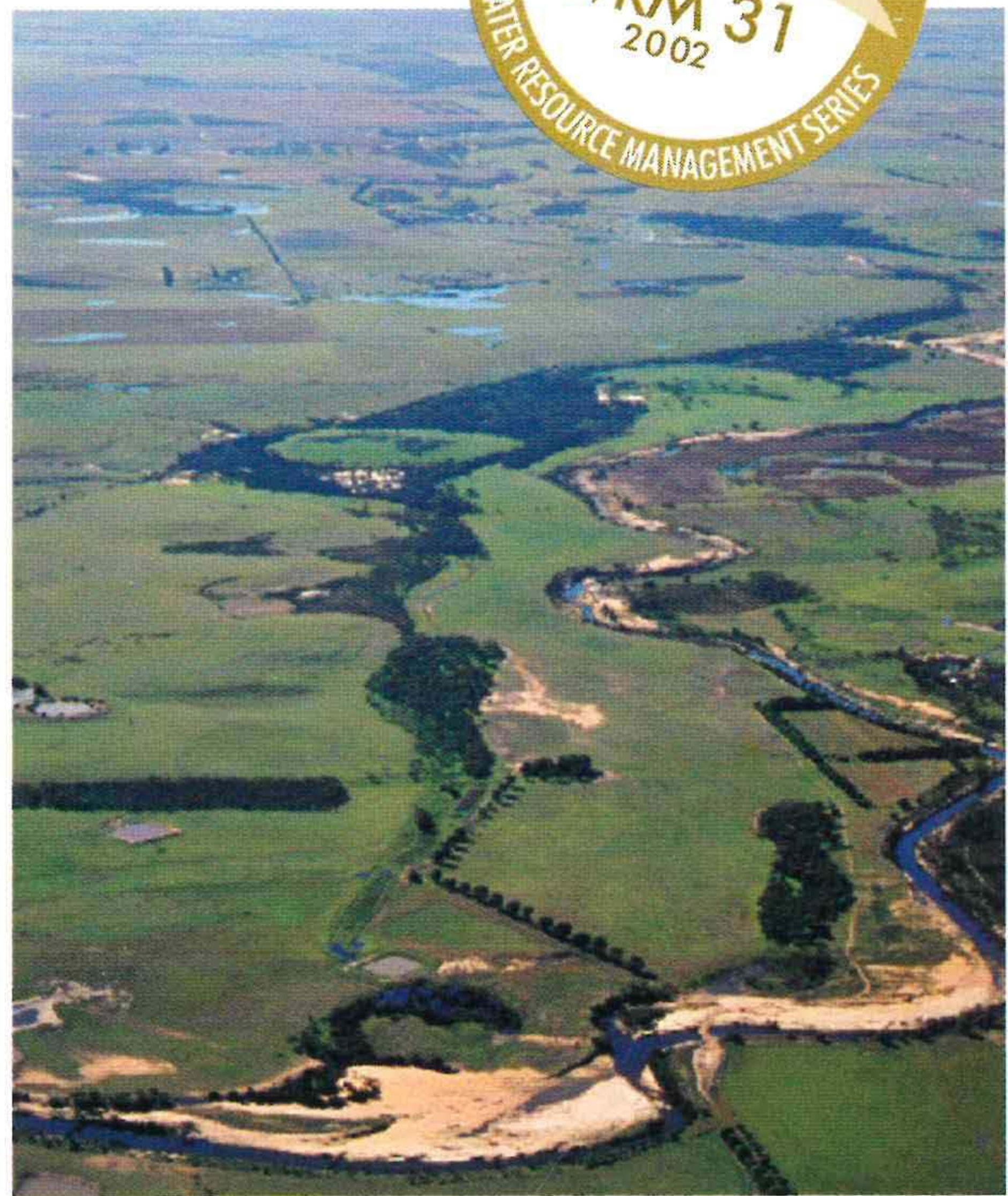




STATEWIDE WATERWAYS NEEDS ASSESSMENT

PRIORITISING ACTION FOR WATERWAYS MANAGEMENT IN WESTERN AUSTRALIA



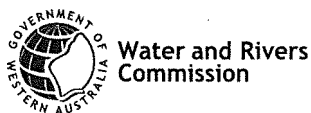
Water and Rivers
Commission

STATEWIDE WATERWAYS NEEDS ASSESSMENT

PRIORITISING ACTION FOR WATERWAYS MANAGEMENT IN WESTERN AUSTRALIA

Resource Management Division

Water and Rivers Commission



WATER AND RIVERS COMMISSION
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Methodology Trial

Thanks to all the Commission staff who took the time to participate in the trial of the methodology.

Disclaimer

This publication has been produced to promote the tool that has been developed to assist in the prioritisation of waterways across WA. The final product, the table of waterway priorities (Table 5) is not, at publication, an agreed priority list of the Commission but is a demonstration of the tool's potential outcomes.

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1 The Waterways WA Program

1.1 Waterways – A treasure to be conserved

Western Australia is, on average, one of the driest places in the world. The climate varies from tropical in the north to Mediterranean in the south. This has created a wide diversity of waterway systems that present management challenges.

In this report, waterways are defined as streams, rivers (and any receiving lake), estuaries or inlets, karsts and wetlands associated with streams. There are 45 estuaries covering 444 square kilometres, 208 recognised rivers totalling 25,000 kilometres in length, 170 named creeks and numerous other smaller tributaries, that form the State's natural drainage system (Water and Rivers Commission 2000).

The community treasures these waterways as places to live near, use for water supplies, recreate on or just enjoy as places of serenity and beauty. Much of the State's biodiversity of plants and animals depends on healthy waterways for long-term survival.

Unfortunately many of our waterways have become seriously degraded through land clearing for farming, grazing, urban development, mining and industrial development. This degradation ranges from erosion, to nutrient enrichment that can cause excessive algal growth, to salinisation. Examples are the eutrophication of the Peel-Harvey estuarine system, salinisation of the Blackwood River and pesticide pollution of the Ord River.

Because our waterways are fragile compared to the more resilient northern hemisphere rivers, management has been a priority almost since settlement began. Waterway management first began in the Swan River in the 1930s in an effort to tackle large algal blooms caused by nutrients coming from the disposal of human and animal wastes close to the river. The specific response was the formation of the Swan River Reference Committee followed by the statutory Swan River Conservation Board, the forerunner of today's Swan River Trust.

Successive governments have continued to respond by forming management bodies until now, where the Water and Rivers Commission (WRC) has statewide

responsibility for waterways management as part of its broader water resources management charter. However, this is also now changing, with the proposed combining of the Water and Rivers Commission with parts of the Department of Environmental Protection to form the Department of Environment, Water and Catchment Protection.

This proposed amalgamation recognises that waterways management is part of water resources management because it includes a whole of catchment approach to natural resources management.

1.2 Natural Resource Management – A context for Waterways WA

Natural Resource Management (NRM) is currently defined in WA as “the ecologically sustainable management of the land, water and biodiversity resources of the State for the benefit of existing and future generations, and for the maintenance of the life support capability of the biosphere”. It does not include mineral or marine resources.

Structures and processes to support NRM include the NRM government departments working in partnership with regional community-based NRM groups and local catchment groups, under a framework of State and regional policies and strategies. An important influence has been Commonwealth funding, initially through the Decade of Landcare and more recently through the Natural Heritage Trust (NHT). This funding has required ‘partnership agreements’ to define the Commonwealth and Western Australian NRM programs. Currently the WA Government has six priority NRM Programs:

- Biodiversity Conservation.
- Coastal Management.
- Rangelands Management.
- The Salinity Strategy.
- Waterways WA.
- World Heritage.

Thus the Waterways WA Program is a key part of the State's evolving NRM strategy. Waterways Management is also important across Australia as shown by the

Commonwealth Government's Rivercare Program, which at \$1.5 billion is the Natural Heritage Trust's third largest program. It will continue as a key component of the extension of the NHT. There is no doubt that sustainable waterways use and management will continue to be a central part of future Natural Resource Management partnerships between Western Australia and the Commonwealth Government.

1.3 The Waterways WA Program at a glance

The Waterways WA Program brings together and coordinates all aspects of waterways use and management in an NRM context. A 'State Policy on Waterways Management' will set a vision for the next 20 years while a 'State Strategy' will define the actions needed to implement the Policy. Other medium and long-term outcomes include:

- Effective floodplain management.
- Environmental water allocations and provisions where needed.
- Restoration and rehabilitation of waterways.
- Inclusion of waterways management in State and Local Government planning processes.
- Responsible control of developments that could adversely affect waterways.
- Management planning and implementation for specific areas.
- Targeted research to better understand waterways management needs.
- Establishing priorities and processes for managing the State's waterways.
- Establishing outcomes, criteria and standards for waterways health across the State on a priority basis.
- Monitoring health indicators and standards, and reporting on the condition of the State's waterways against agreed outcomes and targets.

1.4 Establishing priorities for management

Due to the vast area of Western Australia and the large number and types of waterways, management resources

are limited. It is therefore vital to establish a fair and equitable process to determine which waterways will be managed and by whom. Also, several components of the Waterways WA Program require prioritising. Considerations in the prioritising process include:

- Establishment of the condition, or degree of degradation, of each of the State's waterways. This could include establishing and measuring health and use indicators to detect trends.
- Assigning a value or values to each of the waterways. This may be an environmental, economic, social or cultural value, or a combination of these.
- Identifying the pressures on each waterway, such as water abstraction, drainage or recreational use.
- Identifying the level of management response that exists, as this could be a measure of the importance of the waterway to the local community or to the State.
- Establishing criteria for investment of resources. For example, it would be more expensive to restore a severely degraded waterway compared to a waterway in reasonably good condition.
- Determining the level of community and political support for managing a waterway. For example, there would be more support to manage the Swan River than the Hill River, but there may be a high level of community support to manage a small stream on the south coast.

These considerations have been used in the development of a tool to support management decisions.

The tool is referred to as the "Statewide Waterways Needs Assessment". The aim of this tool is to involve stakeholders in determining priorities for management. The tool involves the assessment of a range of attributes for a waterway and then analysing these into priorities.

1.5 Document structure

The methodology is presented in two parts. Section 2 describes the methodology in its ideal form. Section 3 describes a modified trial of the methodology undertaken by the Water and Rivers Commission.

2 The Statewide Waterways Needs Assessment

2.1 Purpose

The purpose of developing the Statewide Waterways Needs Assessment (SWNA) is to provide a consultative decision support tool which involves all of the key stakeholders, and that will enable prioritisation of the State’s waterways management requirements, including economic, social and ecological considerations. This should enable:

- Clarification of the roles and responsibilities for waterways management.
- Identification of priorities for management within regions and across the State for budgeting, business planning and strategic management.
- Agreement on priorities between community groups, local government authorities and State government agencies.
- Realistic and achievable recommendations to the State Government and valuable information for negotiations with the Commonwealth Government on joint funding programs.
- A sound basis to negotiate partnerships to develop rehabilitation plans and seek additional resources.

2.2 Methodology

2.2.1 The Pressure-State-Response model

The Statewide Waterways Needs Assessment uses the Organisation for Economic Cooperation and Development (OECD) Pressure-State-Response model as the foundation for consistency with State of the Water Resources and State of the Environment reporting (Figure 1). The Commission decided to include waterway values as a key category because they are an important part of the decision-making process. For example, two or more waterways could have similar states (levels of degradation) caused by similar pressures so that determining their value for a range of attributes may be the only way to set priorities for action with limited resources.

The Organisation for Economic Cooperation and Development’s Pressure-State-Response model is shown in Figure 1. It is based on the determined current condition (state) of a natural resource that is being subjected to a range of pressures. This induces change, usually degradation, and information obtained from the change results in a (management) response.

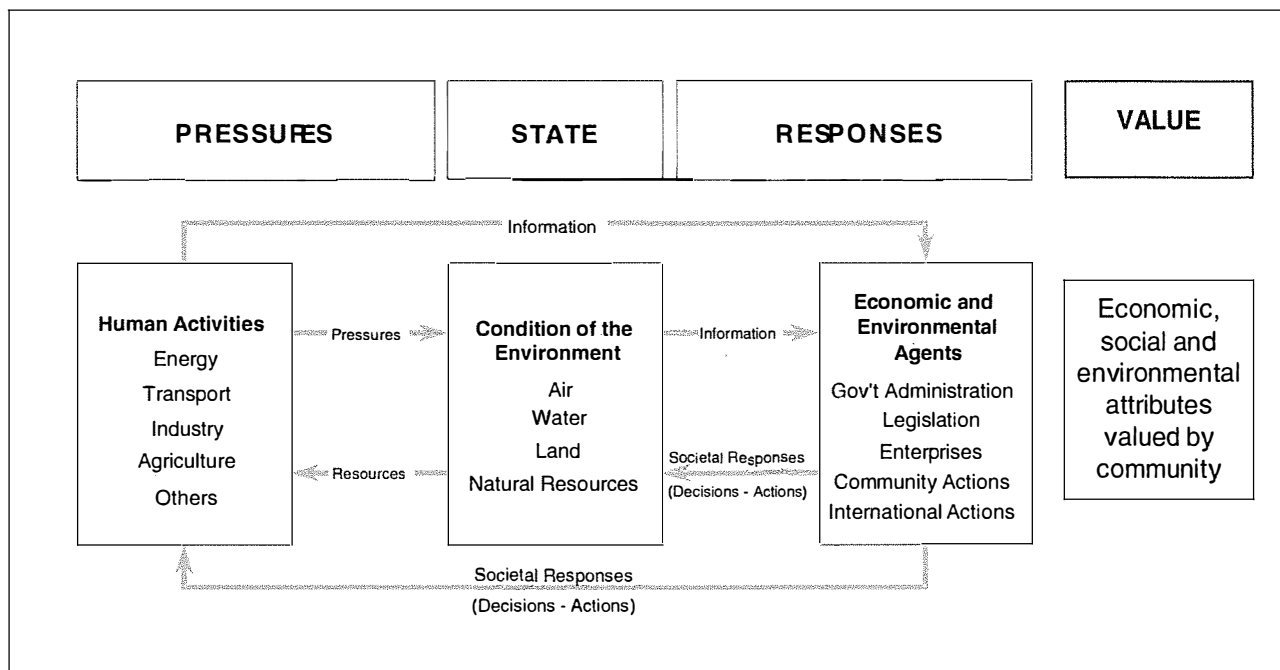


Figure 1. The Pressure-State-Response model (adapted from OECD, 1993)

Such a process can be seen in the Swan River where management responses, as part of the Swan and Canning Rivers Cleanup Program, aim to return the waterway to a clean and healthy condition. Generally, there is a consultative process to establish what the desired condition of the waterway is and then the development of targets that can be monitored, to guide the model in the real situations.

2.2.2 Gathering information – The SWNA questionnaire

The information required to carry out the SWNA is gathered using a questionnaire (Appendix 1). The questionnaire is divided in the following four categories:

1. Waterway Values.
2. Waterway Condition expressed as a level of degradation.
3. Waterway Pressures.
4. Management Responses.

Each of these categories is divided into specific issues that include environmental, economic and social elements in the decision-making process. The categories and issues are shown in Table 1. There are two supplementary questions designed to give an overall perspective of the waterways system but are not used in the determination of priorities. The questions can be changed and modified to suit the boundary and issues being assessed.

Each issue can be ranked into five levels (1 to 5) and responses rated for further analysis (Table 2). It should be noted that a higher rating for:

- Waterway Values indicates a higher value attributed to the waterway.
- Waterway Condition indicates increasing degradation.
- Waterway Pressure indicates increasing land and water use pressures.
- Management Response indicates increasing management responses.

Table 1. The categories and issues in the SWNA questionnaire

Category	Waterways Issues
Waterway Values	<ul style="list-style-type: none"> • Economic benefits • Biodiversity • Uniqueness • Recreation • Aesthetics • Spirituality and culture • Conservation and heritage
Waterway Condition	<ul style="list-style-type: none"> • Erosion and sedimentation • Eutrophication • Salinisation • Feral animals • Weed infestations • Point source pollution
Waterway Pressures	<ul style="list-style-type: none"> • Land development – residential and rural residential • Land development – intensive agriculture • Land development – broad acre farming • Water development – aquaculture, boating facilities • Recreation • Commercial fishing • Industrial discharge • Water abstraction • Agricultural drainage (i.e. coastal plain drainage, saline land drainage)
Management Response	<ul style="list-style-type: none"> • State Government (policy, strategic planning and regulation) • Regional or municipal town planning schemes • Regional strategic planning • Community action • Technical support programs (agency) • Technical solution development • Funding programs
Supplementary Questions	<ul style="list-style-type: none"> • Overall condition • Waterway highlight/lowlight

Table 2. Summary of answers by category

Rating (1 to 5)	Waterway Condition	Waterway Pressures	Management Response Example only (Each response is tailored to the question in this category)	Waterway Values
1	None: the problem does not exist.	None: there is no pressure on the waterway or suite of waterways.	None: no management response is in place or being developed for any issue.	None: the attribute does not contribute in any way to the value of the waterway or suite of waterways at any level.
2	Minor: localised degradation only.	Minor: the pressure affects less than 20% of the waterway or suite of waterways.	Minor: a minority of issues addressed, minimal on-ground responses.	Minor: the attribute contributes to the value of the waterway or suite of waterways at a local level.
3	Moderate: problem is extensive but at a low level or locally-intensive.	Moderate: the pressure affects between 20 and 50% of the waterway or suite of waterways.	Partial: policy/ planning and on-ground responses to about half of the issues or a broad range of policy/ planning responses to most issues.	Moderate: the attribute contributes to the value of the waterway or suite of waterways at local and regional levels.
4	Severe: the problem is widespread and intense but is manageable with the right land use practices and resources.	Severe: the pressure affects between 50 and 80% of the waterway or suite of waterways.	Advanced: policy/ planning responses and on-ground responses to the majority of issues.	Important: the attribute contributes to the value of the waterway or suite of waterways at local, regional and State levels.
5	Extreme: the problem or form of degradation is at the extreme level of the spectrum where it is difficult to see how it could get any worse.	Extreme: the pressure is widespread and affects more than 80% of the waterway or suite of waterways.	Comprehensive: fully developed responses to all waterway issues. On-ground work well advanced.	Significant: the attribute contributes to the value of the waterway or suite of waterways at local, regional, State and national levels.
Unknown: unable to answer question with any certainty.				

This information is collated to develop a questionnaire for an appropriate group of stakeholders. When the answers are reviewed the data is analysed and an agreed prioritisation for the waterways under consideration is established. The generic questionnaire and support to conduct the prioritisation process is available from the Water and Rivers Commission (Appendix 1).

2.3 Six key steps to use the SWNA

There are six key steps to use the SWNA as a decision-making tool that prioritises management needs for a range of waterways, either in a catchment, a region or across the State. Government agencies, Local Government Authorities or community groups can follow these steps:

1. Establish a stakeholder panel and set study area boundaries.

2. Review and adapt the generic WRC questionnaire to suit the circumstances in the study area.
3. Complete the questionnaire.
4. Collate and analyse the results.
5. Review the results against agreed criteria, determine any bias and test the assumptions, and then adjust where appropriate.
6. Panel reaches agreement and documents the final prioritisation.

The following sections briefly summarise the ideal process for using the SWNA tool to develop a preliminary ranking of waterways within an area, which can then be tested against agreed criteria to get a final priority list for decision-making. The Water and Rivers Commission recognises that the SWNA tool needs some adaptation for local circumstances and will assist any groups or organisations. An actual trial of the SWNA is briefly described in Section 3.

2.3.1 Establishing the stakeholder panel and setting the study area boundaries

The stakeholder panel needs professionals and local members with knowledge and experience in different aspects of waterways management and local waterways issues.

Boundaries for the study area will be determined by the group's needs to prioritise management across a particular area, or from a local community group or organisation that wants to prioritise action on its local waterways. Any boundaries should reflect biophysical characteristics and consider administrative and social aspects.

2.3.2 Reviewing the questionnaire

A questionnaire has been developed as a simple and appropriate tool to capture consistent information across the study area and the range of issues set out in section 2.2.1. The value of the questionnaire is to analyse waterways management issues in a form that allows comparison within and across regional boundaries.

A key step in reviewing the questionnaire is to ensure its relevance to the local situation, that it covers all of the issues in Table 1 and includes any additional local issues that are identified.

2.3.3 Completing the questionnaire

To maintain consistency and comparability within and across study areas, the questionnaire needs to be completed using a standardised approach. This can be achieved with advice and support from the Water and Rivers Commission and will include:

- Using explicit examples to highlight the extreme values for each question.
- Explaining the questionnaire and analysing the information for each waterway or sub-region.
- Using a common panel of 'experts' across study areas where practical.
- Focusing on the current Value, Pressures, level of Degradation (state) and Management Responses for the waterways being surveyed.

2.3.4 Evaluating the results

Collation and analysis

The issues (posed as questions) for each of the four categories of Value, Degradation (current state/condition), Pressure and Management Response in the Questionnaire are scored on a scale of 1–5 (Table 2). Scores for the four categories are derived by averaging (or using the median

for larger data sets) the responses to each issue (question). As there may be different numbers of questions in each category, a standardising approach is used to give each category equal weighting. The final score for each category is then tabulated for each waterway assessed within each boundary area.

The next step is to describe the range of scores. For instance, if it was decided to have three categories of 'high', 'medium' and 'low' then the data would be divided into three groups of equal size. To do this the 33 and 66 percentile of the scores are calculated to represent the boundaries between low/medium and medium/high (most spreadsheet software can do this). Therefore the numbers that fall below the 33 percentile are classified as low, above the 66 percentile as high and the results between as medium. If the intended result is to have more or less classifications then different percentile groups can be used; for example, to derive five classes means using the 20, 40, 60 and 80 percentiles of the scores. Note that an increased number of classes, increases the complexity of the process.

Results from the Questionnaire can be used in different ways depending on the emphasis placed on the four categories. For instance, if an assessment of the number of highly-degraded systems was considered most important, then condition would be used as the first category. In this way, the methodology can be adapted to respond to different management needs using only one data set.

Prioritising the waterways

Value is usually the first discriminator used because it is a direct reflection of the current waterway's environmental, economic, social or recreational standing. Degradation is second because it is the prime indicator of the need for management. Pressure is third because it indicates the urgency for responding to improve or maintain the condition of the waterway, taking into account any known changes in the pressures. Using this approach, the waterways can be ranked in a matrix. As indicated previously the discriminator order can change depending on the focus of the process.

'High' Value waterways with 'low' Degradation become the first priority, followed by 'high' Value waterways with 'medium' Degradation and 'high' Value waterways with 'high' Degradation. This is repeated for the 'medium' and 'low' Values to give nine priority groups, as shown in

Table 3. Pressure can be used as a further discriminator if appropriate.

This ranking however is not fixed, but should be used by the panel as a guide to debate further classification of the waterways based on local knowledge and other factors. For example, the question of whether ‘high’ Degradation/ ‘high’ Value waterways should be ranked above or below ‘medium’ Value/‘low’ Degradation waterways should be debated as part of the decision-making process. The former may be more significant than the latter and is shown by a split ranking in Table 3. Consideration may also be given to other things such as changes in pressure.

This is the limit of using the SWNA tool. While it can be used to synthesise a large volume of information to provide a preliminary list of priorities, the ultimate management decisions may not reflect the preliminary list. While this is a very useful way to rank a series of waterways using real data and the input of key stakeholders, it is not a full prioritisation. Full prioritisation requires a further step involving the application of a set of criteria determined to suit the local circumstances or the funding environment.

Table 3. Prioritising waterways using a split-ranking matrix

High Value		PRESSURE		
		High	Medium	Low
CONDITION	High Degradation	3/4	3	3
	Medium Degradation	2	2	2
	Low Degradation	1	1	1
Medium Value		PRESSURE		
		High	Medium	Low
CONDITION	High Degradation	6	6	6
	Medium Degradation	5	5	5
	Low Degradation	3/4	4	4
Low Value		PRESSURE		
		High	Medium	Low
CONDITION	High Degradation	9	9	9
	Medium Degradation	8	8	8
	Low Degradation	7	7	7

The reasons for variations from the preliminary priorities need to be documented because it:

- Sets out the start of the development or use of criteria for management.
- Allows future users of the SWNA tool to understand previous decisions.
- Identifies aspects that may need to be amended the next time the methodology or priorities are used.

For example, a ‘high’ Value waterway with ‘low’ Degradation may be secure in a national park and be well managed, in which case while it ranks as a high priority, it may not be a priority for management effort. On the other hand, the same ‘high’ Value waterway may be in a remote area on crown land, and under increasing pressure for tourism, in which case it should have a higher priority for management effort.

Rutherford and Jerie (1999), in a paper titled ‘Setting priorities for rehabilitating streams: first identify the assets’, discuss how such criteria could be developed. They argue that most of the funding from the Natural Heritage Trust for stream rehabilitation has been used wastefully because it has been directed towards highly degraded waterways that are expensive and difficult to repair. They use the analogy of saving the Titanic before it hits the iceberg, rather than waiting for it to hit the iceberg and then trying to rescue the survivors. They suggest a useful series of criteria for selection of waterways for investment of public funds.

These criteria have been adapted to give the priority ratings listed below.

1. Systems that support valuable organisms, or rare or endangered communities, or are in near-pristine condition. These are ‘high’ Value, ‘low’ Pressure and ‘low’ Degradation.
2. Systems in the best general condition that support a range of use and appear to be withstanding pressures. These would be ‘high’ Value, ‘low-medium’ Pressure and ‘low-medium’ Degradation.
3. Systems where the condition is gradually deteriorating, pressures are increasing and the aim would be to stop further deterioration. These would have ‘medium’ Value, with ‘low-medium’ Pressure and ‘medium’ Degradation.
4. Systems where the condition is significantly deteriorating, pressures are increasing and it would be costly to stop further deterioration. These would be ‘low’ Value with ‘medium-high’ Pressure and ‘medium-high’ Degradation.

5. Systems that are highly degraded with high pressures, which would be very expensive to rehabilitate. These would be of 'low' Value with 'high' Pressure and 'high' Degradation.

Rutherford and Jerie (1999) also discuss whether the waterway is secure in a reserve or national park and what level of management it needs to remain in good condition. They suggest detailed criteria to further refine the priorities and an adaptation of these is shown below:

- If the waterway has a 'high' Value but is secure in a reserve and is not being affected by external pressures, the priority for investment is 'low'.
- If the waterway has 'high' or 'medium' Value and is threatened, the priority for investment is 'high'. If such a waterway can be made secure by reservation or connected to a secure area the priority for investment would be even higher.
- If a waterway has stretches of 'high' Value in good condition that can be connected by rehabilitating poorer sections, the priority for investment would be relatively 'high'.
- If the waterway is 'severely' degraded with 'high' Pressure and would be difficult to manage, the priority for investment would be 'low'.

These examples show that establishing a set of criteria is an essential step in prioritising waterways for management and investment of public or private funds. Such criteria should include the value of the waterway, its security in terms of reservation, its ease of management, its existing condition (level of degradation) and likely changes if nothing is done, risks (e.g. flooding), and community interest in its management.

Generally, ranking waterways values will take precedence but if needed, other categories can be used first. The SWNA provides a valuable set of ranked information about a group of waterways (preliminary priorities), with strong stakeholder input, that can be used to set the final priorities for management by a panel review process.

2.3.5 Panel review of the results and method

The preliminary priorities, that originate from the questionnaire (Table 2) are ordered as 'high', 'medium' or 'low' Value to form the basis of developing the final priorities. Initially, they are used by the panel to agree on

the characteristics of each waterway within the study area and can be used in discussions with other stakeholders.

Panel review is an important part of the process because it allows the panel members to check their interpretations of the answers and the assumptions used in reaching the preliminary priorities. At this stage, the panel will use agreed selection criteria, supplied and/or developed at the local level, to help with the final priorities. Historical and local information from panel members, knowledge of changes that could occur in the future (e.g. spreading salinity) and any other available quantitative information can also be included.

The panel, when carrying out the review phase, needs to consider the following limitations of the questionnaire and analysis of its results:

- **The focus of the questionnaire** – including whether all of the relevant waterway issues have been covered in the study area.
- **The sample size** – where means should be used for small samples and medians for larger samples.
- **The method of administering the questionnaire** – so that the questions are clear with realistic examples and that a panel with professional expertise and local knowledge of the study area is established.
- **Comparing regional results** – when the values and uses of the waterways could be quite different (e.g. comparing the Kimberley Region to the South West of WA, or developing a State list of priorities from regional results).

2.3.6 Agreeing on priorities

All of the panel members should endorse the final product, which will be a document summarising the results of the questionnaire, the limitations of the analysis and the rationale used by the panel to arrive at the final set of priorities. The result will be a useful tool for government agencies and community groups to help allocate scarce resources for the management of a series of waterways.

When done comprehensively, this process provides a well-founded and clear justification for the prioritisation of resources for management, in this case for waterways, with strong stakeholder involvement.

A summary of the process is provided in Appendix 2.

3 Putting SWNA to the test

3.1 Scope of the trial

A trial of the SWNA methodology was conducted with Water and Rivers Commission staff acting as the Stakeholder Panel. They tested the questionnaire, the quality of the data produced and its value for decision-making. Twenty-nine staff in eight regions that cover WA assessed 86 individual waterways and several suites of waterways. A total of 200 waterways were prioritised. A map of the regional areas used can be seen in Figure 2.

3.2 Prioritisation

In the Water and Rivers Commission trial the following category weighting's were used:

1. Value was the highest rating;
2. level of Degradation; and
3. Pressure.

Management response was last and only used to gauge whether the level of management needed to change.

This process produced a set of three by three matrices for 'high', 'medium' and 'low' values, with condition on the vertical axis and pressure on the horizontal axis. Management response was not ordered but was noted in brackets after each waterway (See Table 5). The result was the first level of ranking or preliminary prioritisation.

The following criteria were then adopted to further prioritise the waterways.

Firstly, for waterway systems in all classes of value with 'low' Degradation and:

- 'high' Pressure, it is assumed the waterway is coping, but indicates urgent management may be needed to prevent the system degrading;
- 'medium' Pressure, there is likely to be impacts in the future but not as quickly as with high pressures; and
- 'low' Pressure it is not likely that immediate action is needed providing the waterway is secure in a national park or reserve. However, management could be required to ensure the pressures don't change or to manage any changes so that they do not increase.

Secondly, for waterway systems in all classes of value with 'medium' Degradation and:

- 'high' Pressure, it is assumed the waterway is showing signs of not coping and that management action is required to prevent further deterioration;
- 'medium' Pressure, it is assumed that the waterway is showing some signs of not coping with the pressures but it is not deteriorating as fast; and
- 'low' Pressure, it is assumed that with no action the waterway will continue to slowly deteriorate.

Thirdly, for waterway systems in all classes of value with 'high' degradation and:

- 'high' Pressure, it is assumed the waterway is showing signs of severe stress and that urgent and significant management action is required for recovery;
- 'medium' Pressure, it is assumed the waterway cannot cope with any additional pressures; and
- 'low' Pressure, the waterway cannot cope with any more pressure and would be difficult to recover.

Serious consideration should be given to any action on 'highly' degraded waterways, as the cost and effort in returning them to 'medium' or 'low' Degradation status will be significantly higher than improving waterways with 'medium' Degradation or protecting waterways with little or 'low' Degradation.

Taken together, this was the basis for determining the nine priorities in the trial.

The 'traditional' ranking in Table 4 reflects most of the priorities for funding under the NHT's Rivercare Program as discussed by Rutherford and Jerie (1999). It also illustrates previous management approaches of waiting until a waterway has become severely degraded before taking action. They can be compared to the preliminary priorities that come from the SWNA, which focus more on what will provide the best return and value for any investment of public or private funding.

While this is a reasonably rigorous process, especially when the panel reviews the methodology (see 3.3 below),

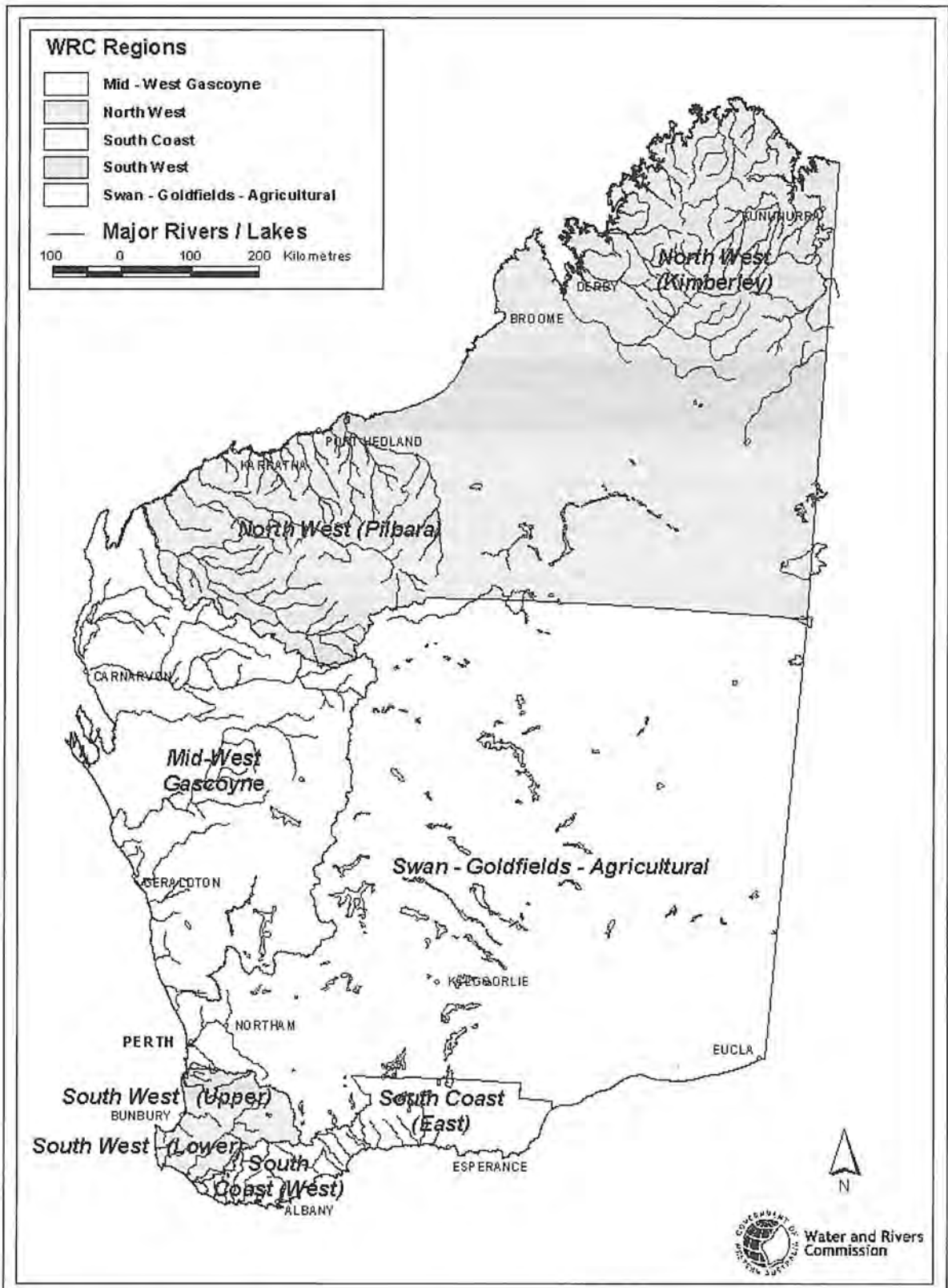


Figure 2. The Water and Rivers Commission regional boundaries and the eight SWNA divisions

Table 4. Prioritisation of waterways in the Water and Rivers Commission trial

		PRESSURE		
		High	Medium	Low
CONDITION	High Degradation	3 (traditionally 1)	6 (traditionally 4)	9 (traditionally 7)
	Medium Degradation	2 (traditionally 2)	5 (traditionally 5)	8 (traditionally 8)
	Low Degradation	1 (traditionally 3)	4 (traditionally 6)	7 (traditionally 9)

there may still be circumstances where the priority is changed for political, social or health reasons. For example, a 'highly' degraded waterway could receive a higher priority because it is treasured by a local community who are prepared to put a lot of their own resources into its rehabilitation.

3.3 Panel review

The 'Regional Panel' (referred to as the Panel) review process involved facilitated regional meetings with staff who had completed the questionnaire. The meetings were organised as mini workshops where the methodology was re-explained and then the matrix for each region was discussed, agreed criteria applied and changes made to reflect the process.

During this process the Panel reviewed the categories that were assigned to each waterway after the questionnaire results were analysed.

For example, the Hill River was ranked: Value = High, Degradation = Low and Pressure = Low. As the questionnaire was based on current values, condition and pressures, the panel considered future scenarios and used these as one of the factors to adjust placement of the waterway in the matrix. The panel review adjusted these rankings to Value = High, Degradation = Medium and Pressure = Medium.

The reasons for reclassifying a waterway were documented and agreed to by the panel. Focusing on the categories of

waterways in the same region, rather than their final priority group enabled open discussion and comparison.

Comparisons only occurred within a region and waterways were not compared between regions. It should be emphasised that the SWNA tool does not provide the final priority list for management. However, it is an essential step in deciding which waterways should receive funding for management.

Criteria that were developed to help set the final priorities included:

- Are the future conditions and pressures likely to change?
- Is the waterway entirely in a national park or reserve or protected site?
- Are parts of the waterway reserved or protected, and/or does the waterway have good vegetation and buffers throughout the catchment?
- Is the waterway similar to any other in the region?
- Does the waterway have high conservation, biodiversity or rare species values?
- Is the level of degradation considered to be different to the questionnaire rating?
- Will the waterway be required for future water supplies?
- Is the level of use and access low?
- Is the waterway a regionally unique example?
- How much effort is required to reverse the degradation or manage the pressures?

There are two methods for developing statewide priorities for waterways management:

1. statewide analysis (combining all scores and determining percentile groups based on the entire dataset in step 1 of the analysis); and
2. regional compilation (where the agreed categories for a waterway are simply combined to generate a statewide matrix).

Both approaches are possible because of the generic nature of the issues being surveyed across the State and the approach within each region was consistent.

The second method is preferred because it includes a strong regional review process reflecting local community and stakeholder input and it more closely reflects how the Water and Rivers Commission's management approach works through 'Water Resource Regions'.

For example, the Hardy Inlet would be ranked priority 3 in the first method but priority 1 in the regional compilation. Any statewide analysis using the second method is considered to be better because quite different types of waterways from the Kimberley to the South Coast will have the same priority, so that management and funding decisions will be more equitable.

Care needs to be taken in moving from one level to another but it is possible to use the methodology at a range of levels from small catchment to river basin, region and the entire State. The composition of the stakeholder panel would change and the questionnaire would need adjusting, but fortunately the SWNA is a versatile tool to prioritise information about waterways in a consistent manner.

Results for the 200 individual waterways and waterway suites are shown in Table 5. *Note: Table 5 is not, at publication, an agreed priority list of the Water and Rivers Commission but is a demonstration of the tool's potential outcomes.*

3.4 Making the management decision

The completion of the SWNA trial, including a panel review process, has given the Commission a sound understanding of how the methodology can be used and outlines priorities for management of 200 waterways throughout the State. The next phase of the process is determining where limited resources should be applied. Several factors will influence the final outcome over time and in any given financial year. These may include:

- Political and community priorities that may differ from the results of the SWNA.
- Consideration as to whether investments in 'high' value/ 'high' Degradation waterways should come before 'medium' value/ 'low' Degradation.
- The existing levels of protection and security of particular waterways and plans to expand national parks and other reserves.
- Examination of future likely pressures such as new development, expanding agriculture, or increasing tourism and recreation.
- The impact of increasing problems such as rising watertables and encroaching salinity.
- The availability of funds and other resources through existing and new funding programs.
- Results from new surveys such as the biological survey conducted by CALM in the last three years in the south-west of Western Australia.

Overall, the trial by Water and Rivers Commission staff shows that the methodology works well and could be adapted for a range of stakeholder panels, geographical areas and resource types (e.g. wetland). In every case it will be important to discuss and agree on the assumptions, priority weightings and selection criteria to be used in the collation and analysis of the questionnaire data.

Table 5. Combined regional priorities

Note: The waterways are listed by regions for quick reference. A table will be developed to group and order all waterways by Priority level.

Region	Priority 1	Priority 2	Priority 3
South Coast - East	Fitzgerald Biosphere (HR) Hamersley Inlet (MR) Hamersley River (HR) Fitzgerald River (HR) Dempster Inlet (LR) Dempster River (LR) Copper Mine Creek (LR)	Fitzgerald Inlet (HR) Jerdacuttup River & Lakes (LR) Lake Warden System Doonabup Creek (HR) Caramup Creek (HR) Kateup Creek (HR) Dalyup River (HR) Coobidge Creek (HR) Coomalbidgup Creek (HR) Bandy Creek	Wellstead Inlet
South Coast - West	King George Sound (NR) Broke Inlet (MR) Shannon River (MR) Eyre River (MR) Big Creek (MR) Inlet River (MR) Walpole River (LR) Deep River (LR) Gardener River (LR) Forth River (MR) Angove River – Angove Lake Goodga River – Moates Lake Black Cat Creek – Moates Lake Denmark River (HR) Walpole-Nornalup Inlet (LR)	Eyre R (MR) Willyun Creek Cordinup River Mullocullup Creek Wonderup Creek Bluff River Waychinicup River King Creek Wilson Inlet (HR)	Oyster Harbour, Princess Royal Harbour (HR)
South West Lower	Hardy Inlet (LR)	Donnelly River (MR) Meerup River (MR) Doggerup Creek (MR) Warren River (MR)	Vasse-Wonnerup wetlands (HR)
South West Upper	Leschenault Inlet (MR) Peel Harvey Estuarine System (HR)	Collie River (LR) Leschenault Estuary (MR)	
Swan Goldfields Agriculture		Brockman River (LR) Avon River (Dale to Mortlock rivers) Dale River (MR) Gingin Brook	
Midwest Gascoyne	Hill River Estuary (HR) Hutt River (MR)	Greenough River Estuary (LR) Hill River (HR)	Moore River Estuary (HR) Murchison River Estuary (HR) Irwin River Estuary (MR)
Pilbara	Robe River (MR)	Harding River Dam upstream (HR) Maitland (Munni Munni) (HR) Sherlock Rivers (HR) Fortescue River (HR)	Munni Munni Creek to Yule River (HR) Harding River Dam downstream (HR)

Table 5 (continued)

Region	Priority 1	Priority 2	Priority 3
Kimberley	Drysdale River (MR) King George River (MR) Berkeley River (MR) Sale River (MR) Glenelg River (MR) Prince Regent River Hunter River (HR) Roe River (MR) Moran River (MR) Charnley River (MR) Isdell River (MR) Calder River (MR)	Drysdale, King George and Berkeley Rivers (MR) Forrest River (HR) Durack River (HR) Salmond River (HR) Chamberlain River (HR) Pentecost River (HR) King River (HR) Ord River Dam upstream (HR) Mitchell River (MR) King Edward River (MR) Ord River Dam downstream (HR) Fitzroy River (HR)	
Region	Priority 4	Priority 5	Priority 6
South Coast - East	Oldfield River (MR) Weamerjungup Creek (HR) Fern Creek (HR) Jenamullup Creek (HR) Thomas River (HR) Blackboy Creek (HR) Alexander River (HR) Munglignup Creek (HR) Duke River (HR)Gentle Creek (HR) Oldfield Estuary (MR) Munglinup River (MR)	Jerdacuttup Lakes (LR) Stokes Inlet (MR) Lake Gor	Culham Inlet (LR) Beaufort Inlet (LR)
South Coast - West	Bowe River (MR)	Irwin Inlet (LR) Karri & Cordubup Creeks Taylor Inlet	Kent River (MR) Kalgan River (HR) King Rivers (HR) Torbay Inlet (MR) Yakamia Creek (HR) Johnston River (HR) Robinson Drain (HR) Torbay MD (MR) Marbellup MD (MR)
South West Lower	Margaret River Mouth (LR) Margaret River (MR)	Scott River (MR) Blackwood Lower (HR) Leeuwin Ridge Streams (LR)	
South West Upper	Harvey River (HR)	Brunswick River	Preston River (MR) Serpentine River (HR) Murray River (LR)
Swan Goldfields Agriculture	Dale River (MR)	East Mortlock River Wooroloo Brook (LR)	Avon River (Beverley upstream)
Region	Priority 4	Priority 5	Priority 6
Midwest Gascoyne	Lakes of Bee Keeper Management Area and other coastal lakes (MR) Lake MacLeod (MR)	Lyndon River to Minilya River (LR) Minor stream systems between Moore and Arrowsmith River (MR) Greenough River (LR)	Murchison River (HR) Gascoyne River (HR) Irwin River Estuary (MR)

Table 5 (continued)

Region	Priority 4	Priority 5	Priority 6
Midwest Gascoyne (Cont)	Murchison River Estuary (HR)	<i>Bowes Estuary</i> Chapman River Chapman River Estuary Gingin Brook (HR)	
Pilbara		<i>Cane River (MR)</i> <i>Yule River (HR)</i>	
Kimberley	Cambridge Gulf (LR)	<i>Morgan River (MR)</i> <i>Carson River (MR)</i> <i>May River (MR)</i> <i>Lennard River (MR)</i> <i>Meda River (MR)</i>	
Region	Priority 7	Priority 8	Priority 9
South Coast - East	<i>Lort River (MR)</i> <i>Young River (MR)</i> <i>Torrakup River (MR)</i> <i>Munglinup River (MR)</i> <i>Collu Collu Creek (MR)</i> <i>Yallabup Brook (MR)</i> <i>Phillips River (MR)</i> <i>Steer River</i>	<i>Gordon Inlet (LR)</i> <i>Lake Shaster (HR)</i>	<i>Cuppup Drain, Munster, Robinson, Torbay</i> Cape Arid to Coomalbidgup (HR) Gairdner River (MR) Bremer River (MR) Bitter Water Creek (MR) Hunter River (MR) Pallinup River (MR) Neridup Creek
South Coast - West	<i>Franklin River</i>	Cheyne Inlet (LR) <i>Hay River (HR)</i> <i>Sleeman River</i> Parry Inlet	<i>Frankland River (MR)</i>
South West Lower	Wellesley River		Blackwood River Boyup upstream (HR) Geographe Bay Streams (HR)
South West Upper			
Swan Goldfields Agriculture			<i>North Mortlock River</i>
Midwest Gascoyne	<i>Hutt Estuary (MR)</i>	Wooramel Basin (LR) <i>Buller River</i> <i>Bowes River</i> <i>Oakabella River</i> <i>Oakajee River</i> <i>Eneabba Creek (MR)</i>	<i>Moore River (HR)</i> Irwin River (MR)
Pilbara		Ashburton River (LR)	<i>Degrey River (LR)</i>
Kimberley			
Low Pressure	Medium Pressure	High Pressure	
HR = high response, MR = medium response, LR = low response and NR = no response			

4 Conclusion

The SWNA methodology provides a useful tool for the collection, analysis, interpretation and presentation of information about waterways to enable management needs to be assessed and prioritised at a range of scales and with different stakeholder groups. The trial, discussed in Section 3 of this report, illustrates that even with limited resources available for developing the questionnaire and conducting the survey in a standardised manner, meaningful results can be obtained.

Collection and analysis of information under the four categories of Values, Condition, Pressure and Management Response, allows explicit consideration of these variables to be made in a structured way through the 'collation tables' and incorporates environmental, social and economic issues as part of the assessment.

The further use of 'prioritisation matrices' allows more complex manipulation of the data by examining assumptions about the order of the categories and by using agreed selection criteria. In turn, this allows detailed debate at both regional and State scales about the resulting waterways prioritisation, which should lead to better decisions about where scarce resources for management are allocated.

The methodology can be adapted to a range of scales, issues and resources.

In summary the SWNA methodology:

- Encompasses broad spatial and temporal scales;
- Is cost-effective.
- Allows full involvement of stakeholders.
- Is flexible and interactive.
- Reproduces well and is easily adaptable.
- Proves to be technically valid while incorporating, environmental, social and economic factors – the 'triple bottom line'.
- Is practical, easily understood and 'user-friendly'.
- Allows assumptions to be tested and a range of selection criteria to be used.
- Provides a sound rationale for weighting and prioritisation against the four categories of Values, Condition, Pressures and Management Responses.

References

- OECD (1993) *Environmental Monographs No. 83 – OECD Core set of Indicators for Environmental Performance Reviews*. Organisation for Economic Cooperation and Development. Paris.
- Rutherford, I. and Jerie, R. (1999) “Setting priorities for rehabilitating streams: first identify the assets!” In Claringbould (Ed.) *Proceedings of the International Landcare 2000 Conference*. Landcare Australia, Melbourne, pp. 193-199.
- Rutherford, I., Jerie, K., Walker M. and Marsh N. (1999) “Don’t raise the Titanic: How to Set Priorities for Stream Rehabilitation” in Rutherford, I and Bartley, R (Eds) *Proceedings of the Second Australian Stream Management Conference – the challenge of rehabilitating Australia’s streams*. CRC for Catchment Hydrology, pp. 527-532.
- Water and Rivers Commission (2000) *Draft - Waterways WA Policy*—supporting document, Water and Rivers Commission, Statewide Policy No 4.

Appendix 1

The Statewide Waterways Needs Assessment Questionnaire

Please read each question carefully and tick the box that most accurately describes your assessment on the answer sheet provided. A separate answer sheet is provided for each waterway or suite of waterways requiring assessment.

A. Waterway condition

To determine the waterways 'needs' within a region, each waterway or suite of waterways is scrutinised against a comprehensive list of issues. These issues are intended to provide information regarding the condition of each waterway or suite of waterways requiring assessment.

Using the scale below (1 to 5) please assess the waterway or suite of waterways for the issues listed (questions 1 to 7).

- 1. None:** the problem does not exist.
- 2. Minor:** localised degradation only.
- 3. Moderate:** problem is extensive but at a low level or locally intensive.
- 4. Severe:** the problem is widespread and intense but is manageable with the right land use practices and resources.
- 5. Extreme:** the problem or form of degradation is at the extreme level of the spectrum where it is difficult to see how it could get any worse.
- Unknown:** unable to answer question with any certainty.

1. Erosion and sedimentation

Various land uses have led to an acceleration in the natural process of erosion within the catchments of waterways. Under low flow conditions sediment is deposited in waterways where it lines banks or fills pools, estuaries and wetlands.

Increases in runoff from catchments and degradation of the watercourse can lead to in-channel erosion where head-cutting and bank slumping of the channel occurs (channels become wider and deeper).

What is the extent of erosion and sedimentation of the waterway or suite of waterways?

2. Eutrophication

The effects of eutrophication are being experienced in many waterways throughout the state, particularly in south west waterways. Some of the symptoms of eutrophication include algal blooms, fish kills, fouling of beaches with macroalgae and loss of important habitat.

What is the extent of eutrophication of the waterway or suite of waterways?

3. Salinity

The permanent removal of perennial vegetation in low rainfall catchments (that have large quantities of salt stored in the soil) has resulted in the reduced evapotranspiration, a rise in groundwater levels, extensive dieback of fringing vegetation and increased salinisation of some waterways.

What is the extent of salinisation of the waterway or suite of waterways?

4. Feral animals

A number of animals introduced by Europeans for transport, stock, sporting and cultural reasons have escaped and/or been released into the wild where they have proliferated. These animals include goats, pigs, horses, donkeys, camels, rabbits, cats, foxes and even fish species like mosquito fish, red fin perch, trout and carp.

What is the extent of feral animal invasion of the waterway or suite of waterways?

5. Weed infestations

A number of introduced plant species have invaded waterways to the point that they dominate the landscape. Among the worst invasive species are plants like watsonia, blackberry, noogoora burr, mesquite and arum lily.

Weed species affect waterways in a number of ways. Many exotic species have soft and deciduous leaves, which contribute to excessive organic loads entering waterways. Also weed dominated riparian areas may not be as effective in preventing erosion and maintaining faunal biodiversity.

What is the extent of weed infestation of the waterway or suite of waterways?

6. Pollution from point sources

Potential point sources of pollution include former landfill sites, industrial and commercial sites, cattle feed lots/stockyards and abattoirs, aquaculture, sewerage pumping/transfer stations, food processing plants and drains containing pollutants.

To what extent are the waterways or suite of waterways affected by point source pollution?

7. Ecosystem fragmentation

Through clearing and other forms of landuse, habitat is declining in extent and health. Habitats are also subject to weed invasion, increased fire frequency, herbicide and fertiliser drift, livestock grazing and altered groundwater levels.

As habitats are destroyed for agricultural, urban and industrial development or through natural resource degradation, they become increasingly fragmented and separated. The lack of connection between habitats exposes populations to the risk of extinction. Opportunities for native species to recolonise become limited while the potential for feral animal and weed invasion will increase.

To what extent is the waterway or suite of waterways affected by ecosystem fragmentation?

B. Waterway Pressures

The following questions focus on pressures exerted on Western Australian waterways. These questions are intended to provide information on the type, and extent of influence, of a range of pressures on the State's waterways.

Using the scale below (1 to 5) please assess the waterway or suite of waterways for the issues listed (questions 8 to 17).

- 1. None:** there is no pressure on the waterway or suite of waterways.
- 2. Minor:** the pressure affects less than 20% of the waterway or suite of waterways.
- 3. Moderate:** the pressure affects between 20 and 50% of the waterway or suite of waterways.
- 4. Severe:** the pressure affects between 50 and 80% of the waterway or suite of waterways.
- 5. Extreme:** the pressure is widespread and affects more than 80% of the waterway or suite of waterways.
- Unknown:** unable to answer question with any certainty.

8. Land development: residential and rural

The pressure from rural and residential land development includes the pressures of urban stormwater drainage and rural drainage.

To what extent is the waterway or suite of waterways affected by residential and rural land development?

9. Land development: intensive agriculture

Intensive agriculture for this assessment would include such land uses as vineyards, orchards, potato and other vegetable horticulture, nurseries, turf farms, piggeries, egg or chicken production, livestock feedlots, dairy milking sheds, shore based aquaculture and land developed for grazing above Agriculture Western Australia stocking rates.

To what extent is the waterway or suite of waterways affected by intensive agricultural land development?

10. Land development: broadacre farming

Broadacre farming involves clearing of native vegetation to develop land for annual crops and pasture.

To what extent is the waterway or suite of waterways affected by broadacre farming?

11. Land development: pastoral

Pastoral land development involves the development of land for pasture with out the clearing of native vegetation.

To what extent is the waterway or suite of waterways affected by pastoral land development?

12. Water development

Water development includes the use of waterways for aquaculture, boating facilities and tourism.

To what extent is the waterway or suite of waterways affected by aquaculture, boating facilities and tourism?

13. Recreation

Recreation, both passive and active, can place pressure on waterways. Activities include camping, picnicking, fishing, marroning, four wheel driving, horse riding, boating, jet skiing and water skiing.

To what extent is the waterway or suite of waterways affected by recreation?

14. Commercial fishing

Some waterways are subject to intensive commercial fishing. Commercial fisheries can place pressure on waterways through the lowering of fish numbers (both target catch and bycatch) and diversity that in turn affects the ecology of the waterways. Other factors associated with commercial fishing that may place pressure on a waterway include: pollution resulting from littering and the use of anti-fouling substances in boat maintenance, fuel spills, disturbance of benthic zones, and bank erosion as a result of bow waves.

To what extent is the waterway or suite of waterways affected by commercial fishing?

15. Industrial discharge

Waterways can be placed under pressure when by-products of an industrial process are discharged into a waterway without satisfactory treatment. Contaminants can cause ecological problems in the waterway and significantly reduce water quality. Industrial discharge can also cause problems when excess water from a process has a significantly different temperature, salinity or pH to the receiving waterbody.

To what extent is the waterway or suite of waterways affected by industrial discharge?

16. Water abstraction

This issue relates to the environmental water requirements of a river ecosystem or groundwater based wetlands. The pressure comes from the diversion of water by damming rivers and extraction of surface and groundwater using pumps or bores.

To what extent is the waterway or suite of waterways affected by water abstraction?

17. Agricultural drainage

This pressure arises from the development of drains and drainage networks on agricultural land to limit waterlogging of pasture and to export saline groundwater from the upper soil profile. Drainage water is generally of low water quality thus placing greater pressure on the receiving waterways.

To what extent is the waterway or suite of waterways affected by agricultural drainage?

C. Management Response

The questions below relate to how society responds to waterway condition and pressures outlined in the previous two sections. Management response issues are intended to provide information on how comprehensive responses have been in addressing the pressures and state issues for each waterway or suite of waterways in the subregion requiring assessment.

18. State Government

Please rate the overall government policy, strategic planning, on-ground action and regulation response for the waterway or suite of waterways.

- 1. None:** no management response in place or being developed for any issue.
- 2. Minor:** a minority of issues addressed, minimal on-ground responses.
- 3. Partial:** policy/planning and on-ground responses to about half of the issues or a broad range of policy/planning responses to most issues.
- 4. Advanced:** policy/planning responses and on-ground responses to the majority of issues.
- 5. Comprehensive:** fully developed responses to all waterway issues. On-ground work well advanced.
- Unknown:** unable to answer question with any certainty.

19. Regional or municipal town planning schemes

What level of water resource management is included in regional or municipal town planning schemes for the waterway or suite of waterways?

- 1. None:** no water resource protection advice sought or included in decisions made by planning authorities.
- 2. Minor:** planning authorities occasionally seek and include water resource protection advice when making decisions.

- 3. Partial:** planning authorities regularly seek and include water resource protection advice in decision making.
- 4. Advanced:** planning authorities have local policy for protection of water resources and/or employ their own environmental officer to give advice on water resource protection advice.
- 5. Comprehensive:** water resource protection practices are included in decision making using one of the following methods;
- Regional Town Planning Scheme.
 - Local Town Planning Scheme, including rural strategies.
 - Statement of Planning Policy (SPP).
- Unknown:** unable to answer question with any certainty.

20. Regional strategic planning

This question relates to the level of agency and community regional strategic planning for management of the waterway or suite of waterways. The question also deals with the level of consultation and integration that occurs with strategic planning.

What is the level of regional strategic planning for the waterway or suite of waterways?

- 1. None:** no management response in place or being developed for any issue.
- 2. Minor:** a minority of issues addressed, minimal on-ground responses. Very few catchment groups that are not particularly active and do not communicate with each other. No regional initiative.
- 3. Partial:** planning and on-ground responses to about half of the issues or a broad range of planning responses to most issues. The catchment groups are very active. The groups may communicate but there is no regional group. There may be numerous local catchment management plans but no regional initiative.
- 4. Advanced:** policy/planning responses and on-ground responses to the majority of issues. There is a regional catchment group(s) and much of the consultation has been completed for the regional initiative. Good communications between regional and local catchment groups and discussions about the development of sub-regional groups.
- 5. Comprehensive:** fully developed responses to all issues. On-ground work well advanced. There is a regional catchment group(s) with a regional initiative. There is good integration and communication between regional and local groups, enhance by the presence of some sub-regional groups. The regional strategy also includes partnership and memorandum of understanding agreements with agencies.
- Unknown:** unable to answer question with any certainty.

21. Community action

Community action includes integrated catchment management (ICM) groups, landcare groups (LG), landcare conservation district committees (LCDC), business and individuals.

What is the level of community action associated with the work undertaken on the waterway or suite of waterways?

- 1. None:** no management response in place or being developed for any issue. There are no active community catchment groups associated with the waterway or suite of waterways.
- 2. Minor:** a minority of issues addressed, minimal on-ground responses. Very few catchment groups that are not particularly active and do not communicate with each other. No regional initiative.
- 3. Partial:** on-ground responses to about half of the issues or a broad range of policy/planning responses to most issues. There are numerous local catchment groups undertaking on ground works on the waterway or suite of waterways.
- 4. Advanced:** there are local catchment groups actively performing on-ground works and there are substantial responses to the issues for the waterway or suite of waterways.
- 5. Comprehensive:** there are numerous local catchment groups actively performing on-ground works and there are fully developed responses to all issues. On-ground work well advanced.
- Unknown:** unable to answer question with any certainty.

22. Technical support programs (agency)

What level of on-ground support is the waterway or suite of waterways receiving in terms of technical support programs?

- 1. None:** no technical support programs in place or being developed for any issues requiring attention.
- 2. Minor:** technical support programs in development phase. No technical support currently being implemented.
- 3. Partial:** technical support programs in development phase. Some technical support being implemented.
- 4. Advanced:** development of technical support programs is well advanced and a significant proportion of issues requiring technical support are being addressed.
- 5. Comprehensive:** fully developed technical support programs in place and all issues requiring technical support are being addressed.
- Unknown:** unable to answer question with any certainty.

23. Technical solution development

For example, research and development conducted by agencies, universities, and the Land and Water Resources Research and Development Corporation (LWRRDC).

To what extent is technical solution development addressing the condition and pressures of the waterway or suite of waterways?

- 1. None:** no technical solution development in place or being developed for any issues requiring attention.
- 2. Minor:** technical solution development in planning phase. No condition and pressure issues are being addressed.
- 3. Partial:** technical solution development in planning phase. Some condition and pressure issues are being addressed.
- 4. Advanced:** technical solution development is well advanced and currently address a significant proportion of condition and pressure issues.
- 5. Comprehensive:** technical solution plans in place and addressing all condition and pressure issues.
- Unknown:** unable to answer question with any certainty.

24. Funding programs

What level of financial support is received from Federal, State or private funding bodies to address relevant condition, pressure and management issues for the waterway or suite of waterways?

- 1. None:** no funding to address any relevant condition, pressure and management issues.
- 2. Minor:** funding received for implementation of investigation and planning stages addressing a small proportion of condition and pressure issues affecting the waterway or suite of waterways.
- 3. Partial:** funding received for implementation of investigation and planning stages addressing all condition and pressure issues affecting the waterway or suite of waterways.
- 4. Advanced:** significant funding received and the investigation and planning stages to address all condition and pressure issues is well advanced. Some funding received for implementation and monitoring of management initiatives.
- 5. Comprehensive:** significant funding received and the investigation and planning stages addressing all condition and pressure issues is complete. Implementation and monitoring of management initiatives is well advanced and funding has been received to ensure ongoing implementation and monitoring for a minimum of three years.
- Unknown:** unable to answer question with any certainty.

D. Waterway Values

Value, as defined by the *Oxford Dictionary*, refers to "...worth, desirability, or utility, or the qualities on which these depend". It is these 'qualities', herein referred to as attributes, on which the worth, desirability, or utility of waterways depend that are the focus of this section of the questionnaire.

Using the scale below (1 to 5) please assess the waterway or suite of waterways for the attributes listed (questions 25 to 30).

- 1. None:** the attribute does not contribute in any way to the value of the waterway or suite of waterways at any level.
- 2. Minor:** the attribute contributes to the value of the waterway or suite of waterways at a local level.
- 3. Moderate:** the attribute contributes to the value of the waterway or suite of waterways at local and regional levels.
- 4. Important:** the attribute contributes to the value of the waterway or suite of waterways at local, regional and State levels.
- 5. Significant:** the attribute contributes to the value of the waterway or suite of waterways at local, regional, State and National levels.
- Unknown:** unable to answer question with any certainty.

25. Economic benefits

A well managed waterway is an asset to landholders, and not just because of the ecological benefits (e.g. biofiltration). A multitude of industries throughout Western Australia (e.g. agricultural, aquaculture, mining, fisheries, tourism etc.) derive economic benefits from waterways. For example, aquaculture and mineral processing industries benefit through the provision of water.

Well managed waterway ecosystems provide numerous economic benefits other than simply the provision of water. Some of these benefits include improved water quality and a decrease in algal blooms and eutrophication due to biofiltration, increases in stock health associated with improved water quality and a reduction in heat or cold stress due to the provision of wind breaks and shelter, a decrease in insect and bird pests that damage pastures and crops, decrease in bank erosion and topsoil stripping, and even an increase in the capital value of the land due to the potential for diversification into areas such as ecotourism.

To what extent do the economic benefits derived from the waterway or suite of waterways contribute to their value?

26. Biodiversity

Biodiversity refers to the variety of genes, species and ecosystems, and is essential to human wellbeing in many ways. It underpins ecological processes that are vital to human health and survival and the continued evolution of life on Earth. Many of the environmental issues raised in this questionnaire affect biodiversity in some way.

To what extent does the biodiversity of the waterway or suite of waterways contribute to their value?

27. Uniqueness

Some habitats and ecosystems are representative of environmental systems that are no longer widespread and are therefore considered unique.

To what extent does the uniqueness of the waterway or suite of waterways contribute to their value?

28. Recreation

A healthy waterway provides pleasant surroundings that are popular for various recreational pursuits. Rivers and the riparian zone are an important recreational resource for fishing, swimming, bird watching, boating and other pursuits.

To what extent do the recreational resources of the waterway or suite of waterways contribute to their value?

29. Aesthetics

The river and riparian zone tend to dominate the local landscape and may also contribute significantly to the regional landscape and so are important to the aesthetic value of an area.

To what extent do the aesthetics of the waterway or suite of waterways contribute to their value?

30. Spirituality and culture

Rivers and foreshores are often places of spiritual and cultural significance. Traditional landowners may have strong spiritual attachments to watercourses. Rivers and foreshores are also places of spiritual significance for non indigenous communities.

To what extent do the spirituality and cultural connections of the waterway or suite of waterways contribute to their value?

31. Conservation

One of the primary aims identified in the State of the Environment Report is to ensure that by the year 2010, all ecosystems within Western Australia are adequately and comprehensively represented in the conservation reserve system and appropriately managed to ensure their viability (see over page for question).

To what extent are the type of ecosystems present in the waterway or suite of waterways represented in the conservation reserve system?

- 1. None:** none of the waterway's ecosystem types are currently included in the conservation reserve system.
- 2. Minor:** less than 20% of the waterway's ecosystem types are currently represented in the conservation reserve system.
- 3. Partial:** between 20 and 50% of the waterway's ecosystem types are currently represented in the conservation reserve system.
- 4. Advanced:** between 50 and 80% of the waterway's ecosystem types are currently represented in the conservation reserve system.
- 5. Comprehensive:** more than 80% of the waterway's ecosystem types are currently represented in the conservation reserve system.
- Unknown:** unable to answer question with any certainty.

32. Overall Condition

Each of the sections above address specific present day issues providing information on the condition of each waterway or suite of waterways. What is the overall condition of the waterway or suite of waterways?

- 1. Poor:** more than 80% of the waterway or suite of waterways have become highly modified since European settlement and are affected by some form of degradation.
- 2. Fair:** between 50 and 80% of the waterway or suite of waterways have become highly modified since European settlement and are affected by some form of degradation. A small number of remnants remain, some or all of which may be influenced by local/regional land uses.
- 3. Good:** between 20 and 50% of the waterway or suite of waterways have become modified since European settlement and may be affected by some form of degradation. Large well preserved remnant patches exist along the waterway or suite of waterways, some of which, are generally unaffected by local/regional land uses.
- 4. Excellent:** less than 20% of the waterway or suite of waterways have become modified since European settlement. A significant portion of the waterway or suite of waterways remains in near pristine condition.
- 5. Pristine:** the waterway or suite of waterways remain in pristine condition and have not changed in any measurable way since European settlement. The waterway or suite of waterways have not at any stage been affected by any form of degradation.
- Unknown:** unable to answer question with any certainty.

33. Waterway highlight/lowlight

Is there a part of this waterway or suite of waterways that you find particularly noteworthy, either because of its high-quality or extreme degradation? Please specify in the space provided on the answer sheet.

If you have any additional comments please use the space provided on the answer sheet.

Appendix 2

Summary of data analysis steps

Steps in analysis

Step 1 Collate results and summarise

A range of statistical analyses can be performed on the questionnaire data. To keep the process simple and easy to understand, the SWNA only utilises averaging methods for processing the data. Based on the WRC trial it is unlikely that sufficient data (>9 responses/waterway) will be collected, allowing a more thorough analysis to occur. If nine or more responses are collected for each question, for each waterway, then there are a number of other statistical tools that can be used to further analyse the data. However, these may not add more clarity than the basic mean (average). These additional tests include:

- Performing correlations between variables.
- Linear regression, used to test the relationships between independent and dependant variables. For example, to test whether the overall condition rating is more strongly related to a personal response for salt condition or erosion.
- Tests for variance.
- Tests for distortion to indicate a non-normal distribution population.

The SWNA primarily focused on each waterway, and each question posed for the waterway (irrespective of category). Only responses where a certain or known answer (1-5) was given were presented in the report's analysis. The percentage of unknown responses for any question or waterway indicates the areas where more knowledge or understanding is required.

The survey data was analysed to get an average response for each question for each waterway. This value could be compared between waterways.

To simplify things more, an overall value for each category of questions for each waterway, was developed. It was decided not to include the final two questions (Conservation and Overall Condition) in calculating the overall value for the Value category as these questions stand alone. Because an average for each question had

been calculated already, these values were treated like raw instead of calculated data. To get an overall value for a category, all average questions' values in a category for a specific waterway were then averaged again. This provides the category mean.

To then determine the summary of each category, the average for each question was combined and then averaged. Ideally the average should have been done on all scores for all questions. However, later assessment showed that the approach that was used in the trial did not significantly alter the results. In a smaller or large respondent group this may become an issue.

Another way of using the data is to determine the most important question (issue) for each region. This was achieved by calculating the mean for each question from the total responses for that question for each waterway to develop a regional priority issue. More specifically, to determine whether eutrophication was an issue for the region, each averaged score for each waterway was combined and further averaged to give a score. This score was then compared with other scores within that category to determine the priority issue in the category. While not a usual statistical method, this is a simple way of determining the average for the category. Data trials indicated no significant difference in results of averaging the average for each question, with determining the average from all the responses.

Responses that recorded 'Unknown' are not included in the calculation of the mean as these would bias the result.

An overall total value for each waterway can also be calculated. This is achieved by adding the standardised totals for all of the categories for the waterway. This provides a single value that can be used to compare all waterways within the State.

Step 2 Tabulate results and determine percentile groups

This step determines the 'high', 'medium' and 'low' groups and includes generating colours for each different percentile group (see main text for process).

Hypothetical Waterway	Value %	Degradation %	Pressure %	Response %
<i>Phil River</i>	30.0	25.0	19.0	25.0
<i>Tenterfield River</i>	33.3	24.3	18.0	24.3
<i>Tree River</i>	29.4	17.9	14.5	16.9
<i>Coloured River</i>	28.3	25.0	17.0	12.9
<i>Fink River</i>	25.0	25.5	15.5	15.7
33 percentile	28.7	24.3	16.0	16.1
66 percentile	29.8	24.7	17.6	21.6

The number is only used to determine the ranking (i.e. 'high', 'medium' and 'low'). The next stages in developing the priority rely only on the assigned colour or letter characteristic (italics and bold). Percentile numbers can be easily calculated using most common spreadsheet packages, including Microsoft Excel.

Step 3 Transferring waterways to the matrix

In this step the waterways are translated into a 27-box matrix.

In the case of the trial, Value was the first discriminator used.

	Pressure		
	High	Medium	Low
High Value			
High Degradation	<i>Phil River</i>		
Medium Degradation	<i>Tenterfield River</i>		
Low Degradation			
Medium Value			
High Degradation			
Medium Degradation			
Low Degradation			<i>Tree River</i>
Low Value			
High Degradation		<i>Coloured River</i>	<i>Fink River</i>
Medium Degradation			
Low Degradation			

Step 4 Matrix of waterway characteristics

	Pressure		
	High	Medium	Low
High Value			
High Degradation	<i>Phil River</i>		
Medium Degradation	<i>Tenterfield River</i>		
Low Degradation			
Medium Value			
High Degradation			
Medium Degradation			
Low Degradation			<i>Tree River</i>
Low Value			
High Degradation		<i>Coloured River</i>	<i>Fink River</i>
Medium Degradation			
Low Degradation			

Priority 1	Priority 2	Priority 3
High Value Low Degradation	High Value Medium Degradation	High Value High Degradation
Priority 4	Priority 5	Priority 6
Medium Value Low Degradation	Medium Value Medium Degradation	Medium Value High Degradation
Priority 7	Priority 8	Priority 9
Low Value Low Degradation	Low Value Medium Degradation	Low Value High Degradation

Therefore the above examples become:

Priority 1	Priority 2	Priority 3
	<i>Tenterfield River</i>	<i>Phil River</i>
Priority 4	Priority 5	Priority 6
<i>Tree River</i>		
Priority 7	Priority 8	Priority 9
		<i>Coloured River</i> <i>Fink River</i>

Step 7 Rank within priority box

This step uses the pressure to rank within the box. For example, if there is more than one waterway in a Priority box then pressure is used to create a relative priority, where the order goes from 'low' Pressure to 'medium' Pressure then to 'high' Pressure.

The above matrix shows the *Coloured* and *Fink rivers* are in the same Priority box. *Coloured River* has 'medium' Pressure and *Fink River* has 'low'. Therefore the final order within the Priority box will be *Fink River* then *Coloured River*. This is done for every Priority box where there is more than one waterway listed.

Step 5 Panel reviews and agrees on characteristics

In this step the panel reviews the previous table and discusses each waterway's characteristics (e.g. 'high' Value, 'medium' Degradation, 'high' Pressure). If the panel considers that some of the characteristics should change they discuss, agree and document the reasons for these changes. See sections 2.3.4 and 2.3.5 for further descriptions.

Step 6 Assigning priorities

This is based on discriminators of Value followed by Degradation then Pressure. Therefore, waterways from matrix with 'high' Value, 'low' Degradation move to Priority 1 box, and with 'medium' Value, 'medium' Degradation to Priority 5 box and the 'low' Value, 'high' Degradation to Priority 9 box.

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