



Goulburn Broken Catchment  
Management Authority

## **Lower Broken Creek Waterway Management Strategy**

Executive Summary

Report



**URS**



July 2005

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# 1. Introduction

## 1.1 Location and Scope

The Lower Broken Creek Waterway Management Strategy has been developed to address the key threats to the natural assets of the Lower Broken Creek. The majority of the natural assets and key threats to the Broken Creek occur within the Lower Broken Creek System, and therefore the Lower Broken Creek Management Strategy was developed focusing on this area. For the purposes of the strategy, the Lower Broken Creek has been defined as the waterways of the Broken Creek downstream of the confluence of the Boosey Creek, including Nine Mile Creek. This covers the five Index of Stream Condition (ISC) Reaches numbers 21, 22, 23, 24 on the Broken Creek (all downstream of the Boosey Ck confluence) and Reach 28 on the Nine Mile Creek. Figure 1 shows the Lower Broken Creek within the study area, while Figure 2 shows the broader catchment with the 5 relevant ISC reaches. Many of the issues identified in the 1998 Strategy for the upper Broken Creek catchment still stand, and the original strategy remains current for this part of the Broken Creek system.

## 1.2 Need for a Revised Strategy

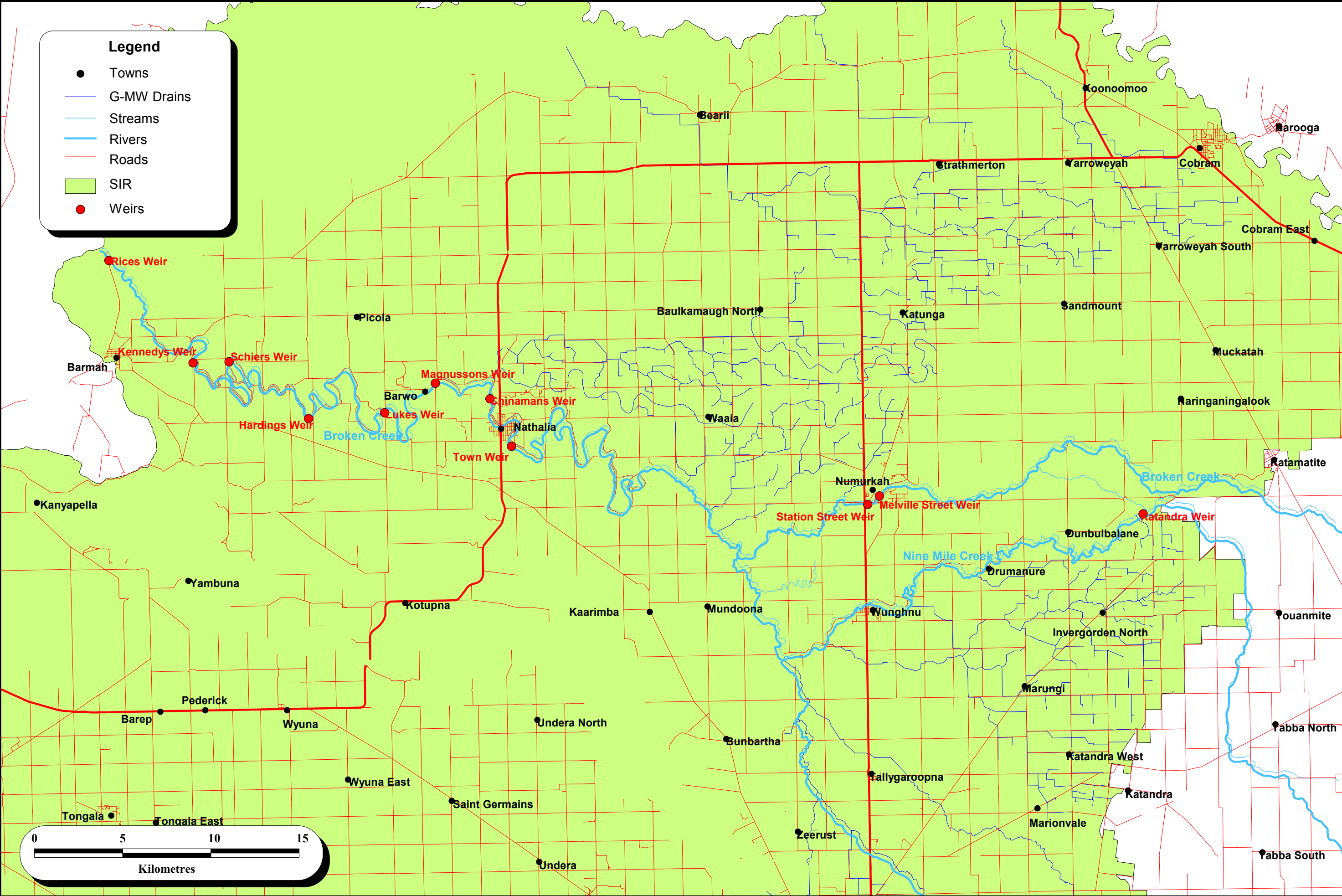
The management of the physical condition of the creeks, water quality and significant flora and fauna are central to the Management Strategy for Broken Creek.

Degradation of the creek environment has not only resulted in a loss of value perceived by those who live along the creek, but also by visitors and tourists who come to enjoy the specific values retained by the environment. Broken Creek is highly prized as one of the best remaining habitats for the Murray Cod and other native fishes, and the four reaches on the Broken Creek are defined as High Priority Waterways within the Goulburn Broken Regional River Health Strategy as a result of their notable high environmental values.

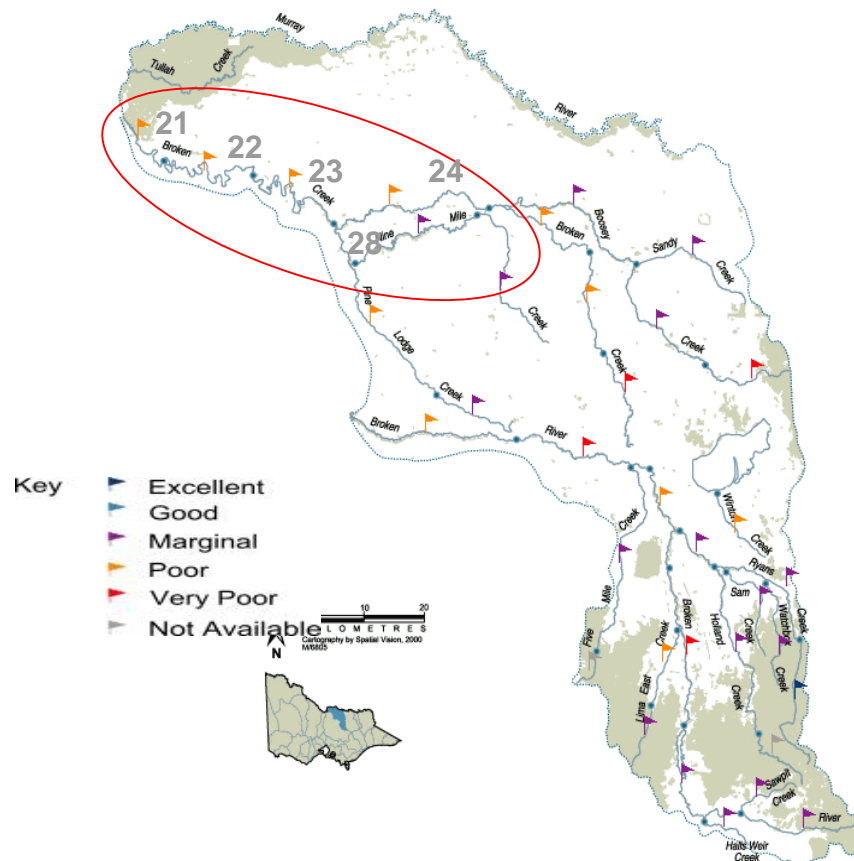
The quality of the water is vital to the residents who live and work near the creek, since it has become a key supplier of water for domestic, stock, urban and irrigation purposes. To a very large degree, the water quality depends on the preservation of the condition of the stream-bed, banks and the riparian zone and the management of water flowing into the creek system from adjacent waterway and land systems.

A Management Strategy for the Broken Creek was first developed in 1998. As part of the development of the current 2005 Strategy, the current status and effectiveness of the 1998 strategy was reviewed. This review indicated that many of the actions set out in the 1998 strategy to address the priority issues at the time have been implemented, however there are some ongoing and emerging issues in the Lower Broken Creek system that have not been adequately addressed or were not covered by the 1998 Strategy. In addition, adequate resource condition targets were not provided to fully measure the success of the original strategy, and so the revised strategy will need to provide measurable resource condition targets.





**Figure 2 Broken Creek catchment and relevant ISC reaches**



- Reach 21 Confluence with River Murray to Schiers Weir
- Reach 22 Schiers Weir to Chinamans Weir (Nathalia)
- Reach 23 Chinamans Weir (Nathalia) to Nine Mile Creek confluence
- Reach 24 Nine Mile Creek confluence to Boosey Creek confluence (downstream of Katamatite)
- Reach 28 Nine Mile Creek

### 1.3 Aim

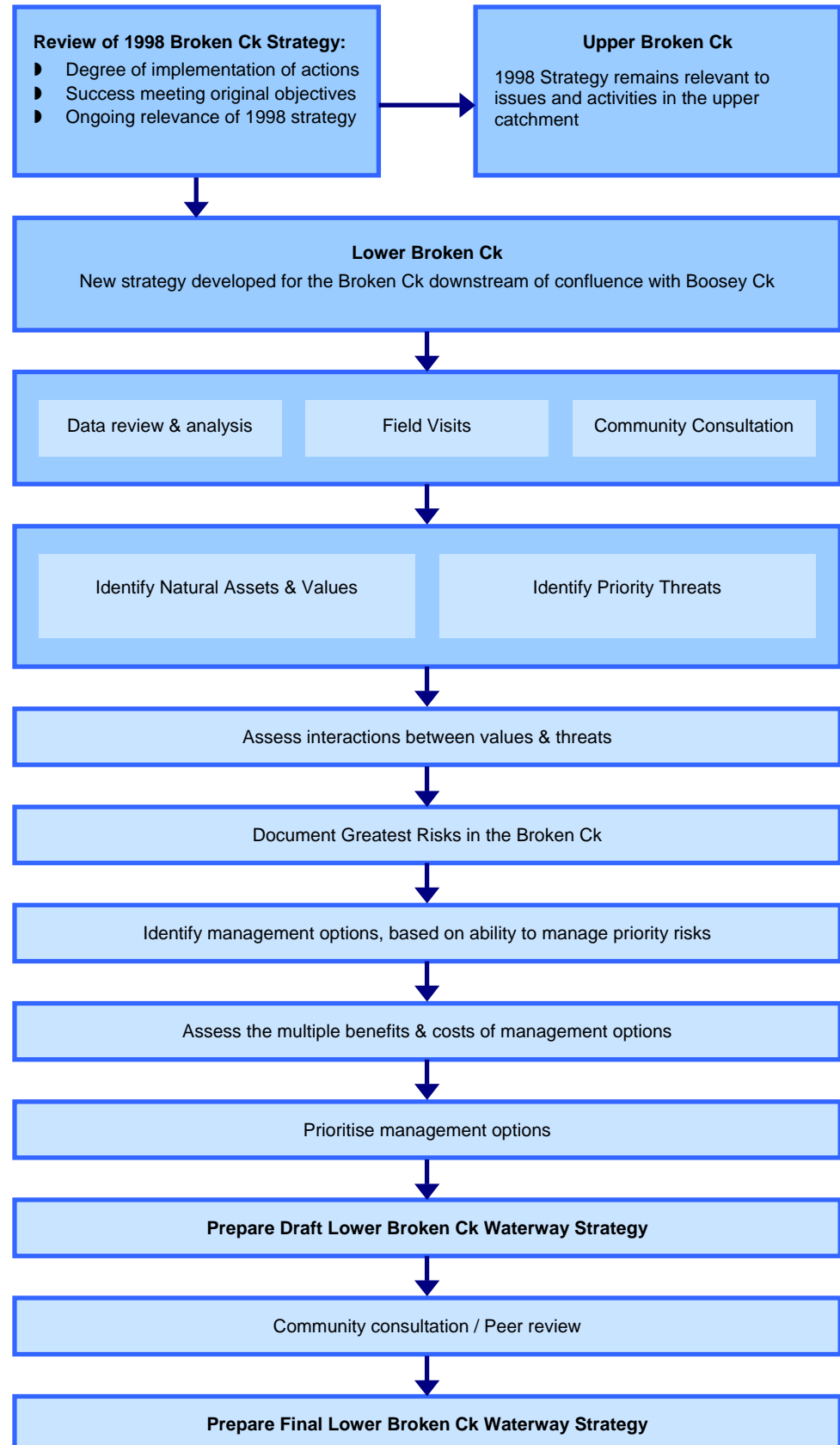
The aims of the Lower Broken Creek Waterway Management Strategy were to:

- ▶ Enhance the health of the Lower Broken Creek, taking into consideration impacts on it by adjacent waterway and land systems; and
- ▶ Establish simple, clear management objectives and targets that can be implemented, monitored and reported on by responsible agencies and the community.

### 1.4 Approach

The process for the review and development of the 2005 Lower Broken Creek Management Strategy is presented in Figure 3.

**Figure 3 Process for the review and development of Broken Creek Strategy**



## 2. The Broken Creek Catchment

The Broken Creek catchment occupies approximately 3 300 km<sup>2</sup> of the Murray Valley Riverine Plains in northern Victoria, and provides regional drainage for the Muckatah, Shepparton, Kaarimba, Invergordon, and Nathalia-Barmah sub catchments. The creek branches from the Broken River north west of Benalla and flows to the north west where it outfalls to the Murray River in the Barmah-Millewa Forest, a RAMSAR listed wetland 210 km downstream. Figure 1 shows the Lower Broken Creek catchment within the study area.

Main towns along the creek include Nathalia and Numurkah. Within the catchment, Katamatite and Tungamah are located on the Boosey Creek and Wunghnu is located on the Nine Mile Creek.

Most of the land in the catchment is used for grazing, with dairying being the predominant industry. The western parts of the catchment are irrigated, with the Shepparton Irrigation District to the south of Broken Creek and the Murray Valley irrigation district to the north of the Broken Creek. Well-developed drainage systems and arterial drains are a feature of the Murray Valley and Shepparton irrigation districts, and many of these drains outfall to the Broken Creek and Nine Mile Creek. There are also substantial constructed drainage systems in dryland areas, including the Drain Road outfall into Boosey Creek upstream of Katamatite and Kreck Road / Sandy Creek near Tungamah. There are also roadside drains, smaller drains, and laser graded drainage lines in the dryland areas of the upper catchment, which may be contributing significant flows to the Broken Creek following rain events.

The Broken Creek catchment lies within the Shepparton Irrigation Region, which is known as the food bowl of Australia, and generates 25 per cent of Victoria's annual rural export earnings. Much of this area falls within Moira Shire, where a population of 25 856 people rely on a regular source of irrigation water that contributes to the Farm Gate Gross Value of Production (GVP) of over \$3 million in Moira Shire. The three irrigation Shires of the Goulburn Broken Catchment (City of Greater Shepparton, Moira and Campaspe) produce 77% of the farm gate GVP in the Goulburn Broken Catchment. This reflects the intensity and diversity of agricultural production that irrigation permits in a relatively low rainfall area. The Broken Creek system is a key source of irrigation water within the Goulburn Broken catchment. More than twenty major food processing companies have located in the Shepparton Irrigation Region, due to the ready access to large volumes of reliably produced raw materials for their production lines and a concentration of infrastructure and services that support their businesses.

Prior to clearing for agriculture, the Broken Creek catchment was largely open woodland, with extensive areas of box eucalypts. Stands of River Red Gums were found in well-watered areas and along waterways.

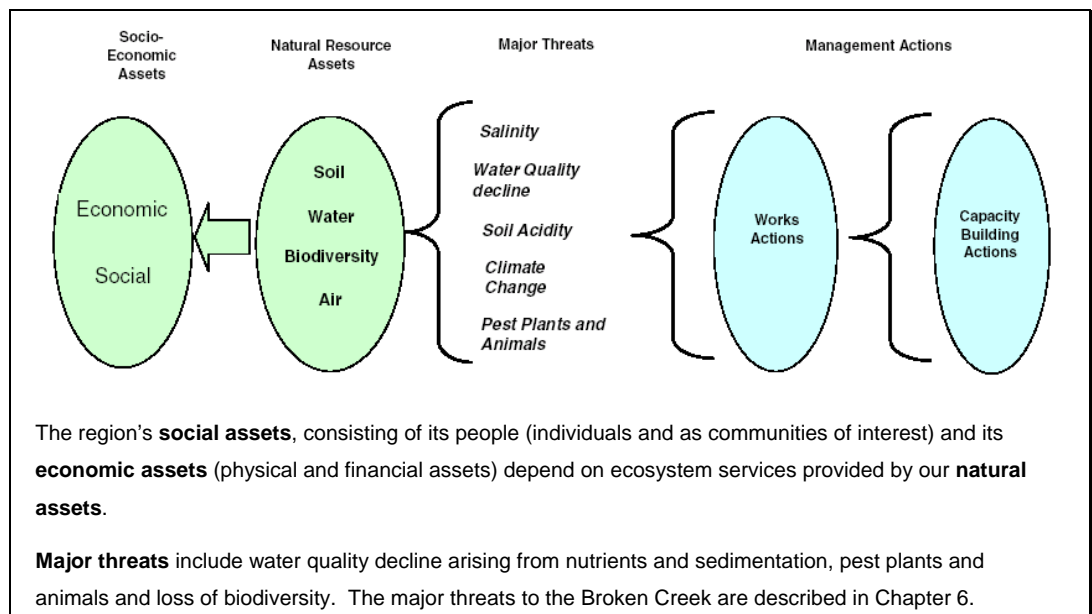


### 3. Natural Assets and Values

#### 3.1 Asset-based Approach to Natural Resource Management

This Lower Broken Creek Waterway Management Strategy has been developed consistent with the asset-based approach to natural resource management described in the Goulburn Broken Regional Catchment Strategy. The Strategy recognises that as our understanding of natural resource management improves we can target our investments so that our environmental, economic and social assets are more efficiently protected. This asset-based framework is diagrammatically represented in Figure 4.

**Figure 4 Assets, threat and action framework – Works Actions target both past and present causes that impact on natural assets**



#### 3.2 Environmental Values of the Lower Broken Creek

The environmental values of the Lower Broken Creek were identified based on expert and community consultation, field assessments and collation of information from a range of environmental databases. The key natural assets and values identified for the Lower Broken Creek by this method are presented in Table 1 below.



**Table 1 Identified Natural Assets and Values of the Lower Broken Creek**

Natural Asset / Value	Description
Significant Fauna	The fauna of the Broken Creek is diverse and represents a range of species due to a complex of habitats available. These include aquatic, riparian and woodland areas that provide habitat to many animal species including some listed species. In the waterway corridor (defined as being within 100 m of the creek) at least 13 significant listed fauna species have been identified, including three fish, a frog, two reptiles, five waterbirds and a mammal species
Significant Flora	The Broken Creek is rated as “high significance” in terms of significant flora throughout the length of the reaches covered by this report. This reflects the presence of endangered and depleted Ecological Vegetation Classes along most of the length of the creek, in a landscape that is largely cleared and intensively farmed. There is almost continuous riparian woodland along the Broken, Boosey and Nine-mile Creeks, although the width of the tree community and intactness of the understorey varies. The aquatic vegetation of the Broken Creek is in a degraded condition. The most common emergent aquatic vegetation along the creek is the exotic weed Arrowhead. The high turbidity of the water is probably a major factor in the rarity of submerged aquatic species.
Significant Wetlands	Some significant wetlands exist in the lower reaches such as those present adjacent to, or within, the Barmah Forest, which is a wetland of international significance.
Water Supply	In addition to being vital for life within the Broken Creek, water is used by local communities for domestic, stock, urban and irrigation supply, and provides important aesthetic and recreational values. Water quality in the Broken Creek is considered degraded mainly due to high turbidity and nutrient levels, which is a threat to these values.
Recreation, Tourism, Cultural Values	The Broken Creek is valued by the community for its recreational values, benefits to tourism and for its European and Aboriginal cultural values.

## 4. Threats to Natural Assets

The key threats to be managed to protect the natural assets of the Lower Broken Creek identified for the 2005 Broken Creek Waterway Management Strategy are presented in Table 2.

**Table 2 Key Threats to Natural Assets / Values of the Lower Broken Creek**

Threat	Description
Stock Access	While stock access has been reduced due to significant fencing of the waterway, there are still areas where fencing is required to protect riparian vegetation and water quality from stock access. In addition, the need to fence channel systems where they enter the creek is considered a high priority by the community.
Poor Water Quality	<p>Poor water quality reflects unfavourable drainage from irrigation areas, urban stormwater runoff, stock access and potential sewerage pollution. This poor water quality is exacerbated by stored nutrients and fine sediments on the bed of the creek coupled with low flows. Even if further inputs of nutrient and sediment are controlled, it is likely that the accumulated store of nutrients and sediments within the Broken Creek will continue to influence water quality for many years to come.</p> <p>Salinity in the Broken Creek is predicted to increase significantly in the next 20 – 30 years, which will require a catchment wide approach to reduce the salinity threat.</p>
Change Flows	Flow regime has been altered from natural conditions for around 50 years. While this has historically been a threat to natural ecosystems, it is likely that the creek ecosystem would have adjusted to the regulated regime. This is reflected by the lower sections of the creek providing a haven for native fish, especially Murray cod, meaning some aspect/s of the flows and/or habitat are supporting these fish. A thorough investigation of the aspects of the current flow regime and the response of the ecosystem to this flow regime needs to be undertaken before substantial changes are made.

Threat	Description
Terrestrial Weeds	<p>Terrestrial weeds are rated as a relatively low risk in most reaches. The willow risk has been greatly reduced by the work that has been done over the last few years. However, other terrestrial weeds including peppercorn, desert ash, canary island date palm, olive, boxthorn, sweet briar have been recorded and are likely to spread without some effort to control them. It has been estimated that without management, terrestrial weeds in particular willows will again become abundant within the Broken Creek.</p>
Aquatic Weeds	<p>Aquatic weeds such as Arrowhead, Cumbungi and Azolla are becoming an increasingly serious problem in irrigation areas. Without future management, it is likely that the risks proposed by aquatic weeds will become substantially worse. The risk from Arrowhead is high and likely to increase, particularly if siltation reduces the depth of the creek bed or weir pools. Lippia also presents a serious potential threat to riparian diversity. It is relatively insignificant in appearance but can dominate the ground cover and reduce diversity. Azolla has become a weed of serious concern following the attribution of the 2002 fish kill to a build up of this species.</p>
Loss of Wetland Connectivity	<p>Approximately 2 500 ha the Broken Creek floodplain is regarded as a “nationally important” wetland, however many of these have been cut off from the floodplain from the construction of levee and changed flow regimes.</p> <p>A number of sites, if "opened up", would allow floodwaters or high flow to enter the floodplain wetlands and improve their condition. Presently no information is available to determine the area of wetlands in the lower Broken Creek that would benefit from being opened up to the floodplain.</p>



## 5. Vision and Management Objectives

### 5.1 Vision

The following Community Vision for the Broken Creek has been identified through consultation with the Community Reference Group:

*“A healthy system that provides water for human and agricultural use, protects and enhances our social, economic and cultural values, and sustains a vibrant range and abundance of native flora and fauna.”*

### 5.2 Management Objective

The following management objectives have been identified in consultation with the Project Steering Committee and stakeholders:

1. Conserve existing genetic diversity.
2. Provide effective water supply that meets the needs of users.
3. Provide regional and irrigation drainage.
4. Maintain and enhance existing riparian vegetation structure and intactness.
5. Enhance in-stream ecological values.
6. Improve the quality of recreational fishing and other recreation opportunities.
7. Improve in-stream water quality to ensure that the above objectives can be met.

It needs to be recognised that achieving these objectives will require some trade-offs, as in many instances there may be conflict between competing objectives. For example, the provision of irrigation and drainage services may have an impact on genetic diversity, or instream ecological values for some species. The role of this management strategy is to find a balance between sustainable use and conservation.





## 6. Management Program

To fulfil the Community Visions and Management Objectives for the Broken Creek, and to address the priority risks to the Lower Broken Creek, a specific Management Program was developed. Table 3 describes each of the key management responses within the program.

For each broad management response described in Table 3, the Lower Broken Creek Waterway Management Strategy identifies a range of specific actions, along with the responsible agency and indicative cost of the action.

In addition, both a management action target and a resource condition target has been set to allow the implementation of the action and its effectiveness in improving the condition of the natural asset of value to be measured. This was a key recommendation from the review of the 1998 Strategy.

The complete Management Program is provided in Appendix A.

**Table 3 Key Management Responses to Address the Priority Risks to the Lower Broken Creek**

Management Response	Description
Fencing & Revegetation	Fencing off of priority riparian areas and channels, the provision of off-stream watering points for watering stock and revegetation of the riparian zone
Enhance Instream Habitat	Provision of Large Woody Debris (LWD) to enhance instream habitat.
Improve Flow Regime	Undertake an environmental flow assessment to guide decisions on changes to the hydrological regime to enhance ecological health, while protecting other social and economic benefits.
Water Quality Management	Stabilisation of bed and banks, riparian vegetation enhancement and management of algal blooms. Maintenance of dissolved oxygen levels to sustain native fish populations.
Catchment Management	While not the main focus of the management strategy, the importance of integrated catchment management to the health of the Lower Broken Creek needs to be considered. This issue is covered more broadly by existing strategies such as the Regional Catchment Strategy, SIR Surface Water Management Strategy, SIR Subsurface Drainage Strategy and the 1998 Broken Ck strategy for the upper catchment.
Drainage Management	Supporting the implementation of the Regional Water Quality and Drainage Strategies, and managing catchment and drain water quality and flow. The IDMOU is developing a decision support system that is a framework to identify drainage issues and develop monitoring to assess them.
Terrestrial Weed Management	Identifying and controlling priority terrestrial weed infestations.

Management Response	Description
Aquatic Weed Management	Identifying and controlling priority aquatic weed infestations.
Bank Erosion & Habitat Management- Nine Mile Ck	Assessment of potential erosion risks associated with proposed works to enhance instream habitat within Nine Mile Creek.
Fish Passage	Evaluation and management of barriers to fish passage within Nine Mile Creek.
Wetland Connectivity	Assessment and implementation of options to enhance wetland connectivity in the Lower Broken Creek.
Cultural Heritage	Protection of aboriginal middens from bank erosion in Reach 21.
Planning	Development of a Fish Action Plan to combine and co-ordinates the range of management responses that will produce greater benefits for fish populations and reduce the risk of future fish kills; Undertake an Environmental Flow Assessment; Development of a Rapid Response Procedure to control weeds.
Communication	Provides actions for enhancing communication of information about the Broken Creek, and improving communication between agencies and the community.
Monitoring & Evaluation	Establishes monitoring and evaluation requirements to evaluate the effectiveness of the Strategy.
Research & Development	Identifies areas where further research will assist in enhancing our understanding of the Broken Creek and improve management responses.

Based on discussions with the Community Reference Group, the following actions are considered the main priorities of the local community:

- ▶ Providing an environmental flow;
- ▶ Improving water quality;
- ▶ Improving waterway monitoring;
- ▶ Managing weeds (willows and arrowhead);
- ▶ Riparian fencing;
- ▶ Retro fitting outfall drains;
- ▶ Improved control of weir gates for managing flow, fish passage, floods; and
- ▶ Application of the Broken Creek Operational Guidelines.

## 7. Implementation and Review

Implementation of the Lower Broken Creek Waterway Management Strategy will need to take advantage of these existing cooperative partnerships and networks, and build on these where any limitations are identified. Table 4 sets out the Roles and Responsibilities for River Health.

**Table 4 Roles and Responsibilities for River Health**

<b>Regional</b>	
<b>Agency / Group</b>	<b>Roles (General)</b>
Goulburn Broken Catchment Management Authority	<p>Develop, in partnership with the community and other stakeholders, the Regional River Health Strategy and other action plans, which define the vision for the catchment and set targets for land and water management.</p> <p>Provide advice to the State Government on both Federal and State resourcing priorities at a regional level.</p> <p>Develop and implement measures for river protection and restoration.</p> <p>Encourage community involvement in river and catchment management.</p> <p>Undertake floodplain management in accordance with the Victoria Flood Management Strategy.</p> <p>Develop partnerships between resource managers in the catchment, and coordinate activities impacting on river health.</p> <p>Provide a focus for regional investment in river and catchment management.</p> <p>Monitor and report on the condition and management of the river and water resources in their region.</p> <p>Provide community education.</p> <p>Act as a communication conduit between regional communities and Government on issues relating to river and water management.</p> <p>Prepare annual works and activity programs for the protection and enhancement of river systems.</p>
Regional Resource Managers (DSE, DPI, GMW and urban Water Authorities)	<p>Participate (as partners) in the development and implementation of the regional RHS.</p> <p>Undertake all activities which can potentially impact on rivers to best practice.</p> <p>Recognise their dependence on a healthy resource base and their potential impact on it.</p> <p>Develop and support partnerships with other resource managers in the catchment to enhance project coordination and implementation.</p>

### Regional

Agency / Group	Roles (General)
Local Government	<p>Work in partnership with CMAs to set priorities and implement the regional RHS.</p> <p>Incorporate river restoration and catchment management objectives, priorities and actions into statutory planning processes.</p> <p>Undertake floodplain management and flood warning in accordance with the Victoria Flood Management Strategy.</p> <p>Develop and implement urban stormwater plans.</p> <p>Manage rural drainage schemes where appropriate.</p> <p>Facilitate local industry involvement in river restoration and catchment management activities.</p> <p>Provide local support for local action groups.</p> <p>Undertake all activities which can potentially impact on rivers to best practice.</p>
Industry	<p>Manage in accordance with the principles of ecologically sustainable development.</p> <p>Minimise their impact on the environment by the implementation of best management practices.</p>
Individuals and Groups	<p>Participate in regional planning, priority setting and the implementation of work programs related to river management and restoration.</p> <p>Participate in community groups aimed at monitoring river health or undertaking restoration projects in priority areas.</p> <p>Manage their own enterprises and actions in ways that acknowledge their 'duty of care' and their role in the stewardship of natural resources.</p>

### State and Federal

Agency / Group	Roles (General)
Commonwealth Government	<p>Contribute funding to States, regional authorities, groups and individuals to achieve national objectives for river restoration and catchment management.</p> <p>Facilitate national or interstate coordination where this is necessary.</p> <p>Invest in the development of better management principles, tools and systems.</p> <p>Improve the knowledge base through strategic research and development.</p> <p>Provide incentives in areas of Commonwealth responsibility.</p> <p>Ensure that the wider Australian community is well informed about natural resource management issues.</p> <p>Facilitate the monitoring of the effectiveness of natural resource management at appropriate scales.</p> <p>Oversee the implementation of relevant Commonwealth legislation including the Environment Protection and Biodiversity Conservation Act 1999.</p> <p>Ensure that Australia meets its obligations under international agreements.</p> <p>Identify issues of national significance.</p>

## Regional

Agency / Group	Roles (General)
State Government	<p>Set statewide policy and strategic directions for river restoration and for catchment and environmental protection.</p> <p>Establish legislative frameworks.</p> <p>Establish effective and efficient catchment / regional institutional arrangements.</p> <p>Provide funding to achieve State and regional priorities.</p> <p>Provide relevant advice, and undertake research and monitoring, planning, extension, on-ground works and some referral and enforcement functions to support regional communities.</p> <p>Participate in effective intergovernmental processes and national approaches where necessary, and implement State responsibilities under nationally agreed strategies.</p>

The Goulburn Broken Catchment Management Authority should be the lead agency responsible for the overall coordination of the Broken Creek Management Strategy. The CMA will be supported by the Shepparton Irrigation Region Implementation Committee, particularly for community engagement and on the ground implementation of the action items. The Goulburn Broken River Health and Water Quality Committee should provide the forum for regional coordination of actions, and as outlined in the Regional River Health Strategy, develop the initial stages of implementation. These stages include monitoring and integrating implementation into the broader activities within the catchment through Implementation Committees and the Waterway Working Groups. In addition, there is a clear role for the broader community to assist with implementing many of the actions, and providing funds under the polluter pays or beneficiary pays principles.

Finally, the Lower Broken Creek Waterway Management Strategy should be an evolving document, which is implemented under a model of continuous improvement. In some instances it has not been possible to set specific resource condition targets as insufficient information exists. In these instances, the first step in the management response has been to undertake sufficient monitoring to identify the baseline conditions, after which resource condition targets should be set.

Under the continuous improvement model, the Broken Creek Strategy's implementation should be evaluated at least annually against its Management Action Targets, and an Annual Report prepared that shows progress on management issues.

The Strategy has been developed with a ten-year timeframe to be consistent with the Regional River Health Strategy, however the Broken Creek Strategy's effectiveness in achieving the Resource Condition Targets should be evaluated every five years, consistent with the review of the Regional Catchment Strategy.







Appendix A

## Specific Management Programs

Lower Broken Creek Waterway Management Strategy



**Table 5 Specific Natural Resource Management Programs for the Lower Broken Creek**

Management Response	Reach	Actions	Responsible Agency	Indicative Cost	Timeframe	Management Action Target	Resource Condition Target
1. Fencing & Revegetation	All	1.1 Identify & map lengths of Broken & Nine Mile Ck that require fencing and revegetation.	GBCMA	\$15 000	Jan 2006	Priority areas identified on GIS based maps	Improve condition of ISC Streamside Zone sub-index by 1-2 points over 62 km river
		1.2 Identify & map sections of channel entering the creek that should be fenced to limit stock access to improve water quality	G-MW, GBCMA	\$5 000	Jan 2006	Priority areas identified on GIS based maps	Maintain condition of riparian vegetation over 61 km of river
		1.3 Assess & develop appropriate delivery mechanisms (eg incentive schemes, others) to maximise fencing & revegetation.	GBCMA; Landholders	\$20 000	Jun 2006	Delivery mechanism developed & implemented	Improved aquatic invertebrate condition
		1.4 Implement the priorities identified in 1.1 and 1.2 using the mechanism identified in 1.3.	GBCMA; Landholders	\$1 M See Table 31, Strategy Ch 13.	Dec 2006 to Dec 2010 (8 km/yr)	305 km frontage fenced as: 245 km Broken Ck <sup>3</sup> 60 km Nine Mile Ck	Improvement in surface feeding fish species (Galaxiids, and smelt) abundance & diversity compared to 2005 baseline
		1.5 Encourage land managers to adopt Current Recommended Practices (CRP) for "Managing grazing in riparian zone" <sup>1</sup>	GBCMA; DPI	See Table 31, Strategy Ch 13.		305 km frontage under CRP	
		1.6 Control grazing on public waterfronts <sup>2</sup>	DSE / Parks Vic			305 km frontage controlled	

<sup>1</sup> refer to Table 9.5 in GB Regional River Health Strategy

<sup>2</sup> refer to Table 9.5 in GB Regional River Health Strategy

<sup>3</sup> 245 km represents the total length of Broken Ck. It needs to be recognised that 82.5 km of the Broken Ck was fenced under the 1998 Strategy, some areas have been fenced historically, and other areas may not require fencing (eg where the riparian corridor includes property access roads). These targets could therefore be further refined if further information can be obtained.



Management Response	Reach	Actions	Responsible Agency	Indicative Cost	Timeframe	Management Action Target	Resource Condition Target
2. Enhance Instream Habitat	All	2.1 Assess the benefits and risks of enhancing LWD in Nine Mile Ck	GBCMA	\$5 000	June 2007	Assessment complete	Improved channel stability over Nine Mile Creek
		2.2 Depending on the outcomes of 2.1, introduce large woody debris into most reaches of the Nine Mile Creek.	GBCMA	\$700 000	Jun 2007 to Jun 2008	LWD installed along 10 km of Nine-Mile Ck	Improvement in snag loving fish species (Murray Cod, Golden Perch and gudgeons) abundance & diversity compared to 2005 baseline
3. Improve Flow Regime	All	3.1 Undertake an environmental flow assessment for the Broken Creek to determine an appropriate flow regime, giving particular attention to: <ul style="list-style-type: none"> <li>– assessing the flow requirements for particular fish populations of the creeks system;</li> <li>– identifying options for improved ecological health.</li> </ul>	GBCMA; G-MW	\$150 000	Jan 2006 to Jul 2006	Environmental flow assessment complete	Improvement in fish species abundance & diversity compared to 2005 baseline
		3.2 Based on the outcome of the environmental flow assessment, obtain a secure environmental flow for the Broken Creek	GBCMA; G-MW	To be determined	Dec 2006	Environmental flow secured.	Improvement in fish species abundance & diversity compared to 2005 baseline by 2010
4. Water Quality Management	21, 22, 23, 28	4.1 Investigate benefits / cost of options to manage excessive azolla grow at Rice's Weir, including current practice of providing passing flows (also refer to 3.1).	GBCMA; G-MW	\$5 000	Dec 2007	Investigation complete	Compliance with SEPP dissolved oxygen objectives; no excessive azolla growth at Rices Weir; Flows targets met.
		4.2 Identify & develop appropriate options for managing excessive azolla growth, giving consideration to social, environmental & economic costs & benefits.	GBCMA; G-MW	\$10 000	Dec 2007	Guidelines developed	When they become available, adopt targets under the IDMOU, however in the interim, improve nutrient and turbidity water quality attainment towards SEPP (WoV) requirements.
		4.3 Assess the impact of current legal practices within riparian areas (such as grazing, recreation) on river health and	GBCMA, DSE, DPI	\$20 000	Dec 2008	Assessment complete	

<sup>4</sup> Refer to GBRRHS Table 9.5.



Management Response	Reach	Actions	Responsible Agency	Indicative Cost	Timeframe	Management Action Target	Resource Condition Target
		grazing, recreation) on river health and water quality, and identify appropriate action to manage.					Consider developing site specific trigger values based on 80 <sup>th</sup> percentile of existing water quality data.
		4.4 Encourage implementation of the GB Water Quality Strategy in the Broken Creek.	GBCMA	See Table 26, Ch 13.	Ongoing	Relevant actions to Broken Ck implemented	
		4.5 Encourage land managers to adopt CRP for "Stabilising Bed and Banks" <sup>4</sup>	GBCMA	See Table 31, Strategy Ch 13.	Ongoing	40 km of stream under CRP	Target achieved within identified timeframe.
		4.6 Stabilise instream and near stream erosion (Reach 23)	GBCMA	\$50 000 (10 km @ \$5000/km)	Dec 2008	Banks stabilised over 10 km of stream	
		4.7 Develop targets for water quality as defined by the Irrigation Drainage Memorandum of Understanding Rapid Decision Support Scheme (also see Section 10 – Monitoring)	GBCMA	\$15 000	Dec 2006	Water quality targets developed in accordance with IDMOU Rapid Decision Support Scheme	
		Also see actions under Fencing & Revegetation, and Wetland Connectivity					
5. Catchment Management		5.1 Support the implementation of actions relevant to the Broken Creek identified within broader strategies such as: <ul style="list-style-type: none"> <li>– Regional Catchment Strategy</li> <li>– SIR Subsurface Drainage Strategy</li> <li>– SIR Surface Water Management Strategy</li> </ul>	GBCMA	See Table 31, Strategy Ch 13.	Ongoing	Programs implemented	Not applicable, as covered by more specific resource condition targets set for other Management Responses.
6. Drainage Management	21, 22, 23	6.1 Encourage implementation of existing water quality and drainage strategies in the Broken Creek, giving consideration, as appropriate, to:	DPI, GBCMA; Landholders	See Table 31, Strategy Ch 13..	Ongoing	Programs implemented	When they become available, adopt targets under the IDMOU, however in the interim, improve nutrient and turbidity water quality attainment towards SEPP (WoV) requirements.





Management Response	Reach	Actions	Responsible Agency	Indicative Cost	Timeframe	Management Action Target	Resource Condition Target
		<ul style="list-style-type: none"> <li>managing farm nutrient run-off to reduce volumes &amp; improve quality</li> <li>managing drains to re-use drainage water to reduce run-off to Broken Creek &amp; Nine Mile Creek; and</li> <li>constructing new drains according to existing best practice and implementing the strategy of retrofitting existing drains to reduce nutrient loads. This may include establishing in-line or off-line wetlands along irrigation drains to reduce nutrients and manage outflows to high flow events in the Creek.</li> </ul>					
7. Terrestrial Weed management	21, 22, 24, 28	<p>7.1 Identify &amp; map terrestrial weed species &amp; priority management areas within the riparian zone of the Lower Broken Creek system</p> <p>7.2 Conduct targeted control programs (Willows, other known species)</p> <p>7.3 Maintain areas of previous terrestrial weed removal</p> <p>7.4 Maintain good information resources on potential weeds for the local community, who are most likely to detect new infestations</p> <p>Also see actions under Management Response No. 1 - Fencing &amp; Revegetation</p>	<p>GBCMA</p> <p>GBCMA</p> <p>GBCMA</p> <p>GBCMA; DSE</p>	<p>\$20 000</p> <p>\$20 000/yr (4 km/yr @ \$5000/km)</p> <p>\$5 000/yr</p> <p>See Mgmt Resp 13</p>	<p>Dec 2006</p> <p>Dec 2006 and Ongoing</p> <p>Ongoing</p> <p>See Mgmt Resp 13</p>	<p>Terrestrial weeds mapped and prioritised</p> <p>Target control program developed &amp; implemented</p> <p>Previously treated areas managed</p> <p>See Mgmt Resp 13 - Communication</p>	<p>Terrestrial weed infestations controlled (specific targets to be developed after initial survey).</p>
8. Aquatic Weed Management	21, 22, 24, 28	<p>8.1 Assess and map the present extent of aquatic weed infestations (Arrowhead, Azolla, Lippia and other identified weedy species) &amp; identify priorities for management, which may include:</p>	GBCMA; G-MW	\$20 000	Jun 2006	Aquatic weeds mapped.	50% reduction in weed infestations of highest risk (Arrowhead, Azolla) compared to 2006 baseline (to be determined); other weeds monitored and controlled as required.



Management Response	Reach	Actions	Responsible Agency	Indicative Cost	Timeframe	Management Action Target	Resource Condition Target
		<ul style="list-style-type: none"> <li>– trials of water level regimes to control arrowhead; and</li> <li>– increased variability of flows to provide low flow periods, particularly in autumn periods.</li> </ul>					
		8.2 Implement an appropriate targeted control programs to control aquatic weed species	G-MW	\$80 000/yr for 3 years	Jan 2009	Target control program developed & implemented (extent to be determined)	
		8.3 Implement a maintenance program to manage aquatic weeds controlled in 8.3.	G-MW	\$50 000/yr	Ongoing	Maintenance program developed & implemented	
		8.4 Maintain good information resources on potential aquatic weeds for the local community, who are most likely to detect new infestations.	GBCMA; G-MW	See Mgmt Resp 13.	See Mgmt Resp 13	See Mgmt Resp 13 – Communication	
		8.5 Develop a rapid response procedure for any new weed species that may be likely to become a threat to the Broken Creek environment	GBCMA; DSE	\$10 000	Dec 2006	Rapid response procedure complete Staff trained	
9. Bank Erosion & Habitat Management - Nine Mile Ck	28	9.1 Undertake an assessment of erosion risks in the Nine Mile Ck and ensure bed and bank stability is taken into account when plans for habitat improvement are implemented (Refer also to Mgmt Response 2 – LWD)	GBCMA	\$10 000	Prior to works starting	Assessment complete & documented	Banks stabilised over 30 km of Nine Mile Creek.  Reducing turbidity in Nine Mile Creek towards achieving SEPP (WoV) requirements
		9.2 Encourage land managers to adopt CRP for “Stabilising Bed and Banks” <sup>5</sup>	GBCMA	See Table 31, Strategy Ch 13.		30 km of Nine Mile Ck under CRP	

<sup>5</sup> From GBRRHS Table 9.5



Management Response	Reach	Actions	Responsible Agency	Indicative Cost	Timeframe	Management Action Target	Resource Condition Target
10. Enhance Fish Passage	28	10.1 Assess the structures and barriers present within Nine Mile Creek & develop options to improve fish passage	GBCMA	\$15 000	Jun 2010	Study of barriers to fish movement in Nine Mile Ck completed	Improvement in fish species abundance & diversity compared to 2005 baseline (see Mgmt Resp 14 - Monitoring & Evaluation)
		10.2 Provide fish passage, including simple rock structures (not necessarily complex fishways), as required	GBCMA	\$100 000/ barrier		Removal of barriers to fish movement complete, where deemed to be cost-effective.	
11. Enhance Wetland connectivity	22	11.1 Explore & assess opportunities to re-connect cut-off meander loop wetlands (Billabongs), which have been previously alienated from creek flows, including mapping of all potential wetlands & benefit/cost analysis of relative options	GBCMA	\$60 000	Dec 2008	Potential wetlands mapped, and options for reconnection to the Broken Ck assessed.	To be determined, but to include a river & wetland target relative to baseline (including water quality, habitat, riparian vegetation)
		11.2 Based on the outcome of the above study, re-connect two cut-off meander loop wetlands where deemed to be cost-effective.	GBCMA	\$120 000	Jun 2010	Two wetlands re-connected, as appropriate.	
		11.3 Continue to develop and implement wetland management plans for Kinnairds Swamp, Green Swamp, and other significant wetlands associated with the Broken Ck	GBCMA	\$20 000	Ongoing	Two wetland management plans developed by 2010	
12. Protect Cultural heritage	21	12.1 Undertake specific works in Reach 21 (downstream of Rices Weir) to protect Aboriginal middens	GBCMA	\$ 10 000	Dec 2006	Works completed	Aboriginal middens protected
13. Planning	All	13.1 Develop Fish Action Plan to co-ordinate and communicate activities aimed at benefiting fish, including recreation and tourism	GBCMA	\$10 000	Dec 2006	Plans / Procedures developed	Improvement in fish species abundance & diversity compared to 2005 baseline.
		13.2 Develop a policy and guidelines for managing camping and recreation in areas outside Nature Feature Reserves and the State Park.	GBCMA	\$10 000	Jun 2007		Prevention of establishment of any new weed species along the Broken Ck.
		13.3 Develop a regional policy and program for addressing illegal recreation and grazing	Community reps, DPI,	\$15 000	Dec 2007		



Management Response	Reach	Actions	Responsible Agency	Indicative Cost	Timeframe	Management Action Target	Resource Condition Target
		13.4 Develop a Waterway Action Plan for the Lower Broken Creek to link strategic issues identified in this strategy to local issues, and to provide a specific works program.	DSE, GBCMA, Parks Vic				
			GBCMA	\$ 15 000	Dec 2005		
		13.5 Develop a Rapid Response Procedure for Aquatic Weed Management (see Mgmt Resp 7)	See Mgmt Resp 7	See Mgmt Resp 7	See Mgmt Resp 7		
		13.6 Undertake an Environmental Flow Assessment (see Mgmt Resp 4)	See Mgmt Resp 3	See Mgmt Resp 3	See Mgmt Resp 3		
14. Communication	All	14.1 Ensure the Communication Strategy for Riverine Health from the RRHS and the SIR Communication Strategy are implemented to clarify agency roles and responsibilities and gain community input to managing threats and improving the environmental values of the Broken Ck	GBCMA	\$15 000	Dec 2006	Communication Strategy developed & implemented; Community action enhanced	Not Applicable
		14.2 Provide local community with information of the creeks ecology and water quality including the elements they can assist with management (riparian vegetation; spills and run-off; flow management) of the creek	GBCMA	\$10 000	Jun 2007	Information resources developed; community aware of issues.	
		14.3 Maintain good information resources on potential weeds for the local community, who are most likely to detect new infestations		\$11 000	Dec 2007	Information resources developed; community aware of issues.	



Management Response	Reach	Actions	Responsible Agency	Indicative Cost	Timeframe	Management Action Target	Resource Condition Target
15. Monitoring & Evaluation	All	15.1 Continue ongoing monitoring and assessment of water quality in the Broken Creek at Rices Weir and Katamatite to allow assessment of management responses and allow for adaptive management of the system. This should be consistent with the approaches within the ID MOU	GBCMA; G-MW	\$50 000/yr	Ongoing / Annual to 2015	Annual report on water quality monitoring results and trends completed.	Not Applicable
		15.2 Collect baseline data on fish, macroinvertebrates, instream and riparian condition	GBCMA; DPI	\$30 000 (for 10 sites)	Jun 2006	Baseline data collected and reported.	
		15.3 Establish appropriate resource condition targets for fish etc based on baseline data	GBCMA; DPI		Dec 2006	Targeted resource condition targets developed.	
		15.4 Establish an ongoing monitoring program for fish, macroinvertebrates, instream and riparian condition to allow assessment of management responses and allow for adaptive management of the system.	GBCMA; DPI	\$30 000	Jun 2007	Report of resource conditions against baseline provided every 5 years.	
16. Research & Development		16.1 Investigate other approaches for riparian revegetation, such as: <ul style="list-style-type: none"> <li>– Use direct seeding to re-establish more native vegetation.</li> <li>– Use fire management to stimulate germination of native vegetation.</li> <li>– Use direct seeding to re-establish more native vegetation</li> </ul>	GBCMA, DPI	\$10 000	Jun 2007	Approaches assessed and documented.	Not Applicable
		16.3 Use fire management to stimulate germination of native vegetation					





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#### Document Status

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