
AVON WATERWAYS COMMITTEE
RIVER RECOVERY PLAN
Section 14,15,16 – Beverley to Qualandary Crossing

prepared by
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for
Water and Rivers Commission
and
Avon Waterways Committee

As of 31 December 2001 the name of the
Avon River Management Authority has
changed to Avon Waterways Committee

WATER AND RIVERS COMMISSION
RIVER RECOVERY PLAN
REPORT No RRP 5
JANUARY 2002

Acknowledgments

This recovery plan was prepared under the direction of the Avon Waterways Committee, with the support of officers of the Water and Rivers Commission.

The following members of the Beverley/Kokeby/Bally Bally communities acted voluntarily on an advisory committee during the preparation of the plan:

Allan Ellis, Amanda McLean, Anne Behn, Bill Cole, Di Congreve, Dorothy Sampson, Fred Bremner, Henry Ugle, Jenny James, Judi Jenkins, Kate Badger, Margaret Andre, Mitchell Henry, Natalie Kilpatrick, Nookie Ridgeway,

Peter Congreve, Phyllis Facey, Reg Behn, Shane Moad, Steve Smart, Ted Sampson, Trevor McLean, Vin Szczecinski and Wally MacMillan.

The group attended meetings, undertook a field trip and worked on drafts of the plan, and have already commenced some of the work listed.

Roger Underwood of York Gum Services was the project facilitator and planning consultant.

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Avon Waterways Committee

We welcome your feedback

A publication feedback form can be found at the back of this publication, or online at www.wrc.wa.gov.au/public/feedback/

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Eyres Pool

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1 Introduction

1.1 The Avon River

This Recovery Plan deals with the section of the Avon River from the outflow of the Yenyening Lakes below Qualandary Crossing to the upstream of Beverley townsite. It is referred to in this plan as the ‘Kokeby’ section, after the name of the railway siding located midway along the section.

The Kokeby section of the river is designated as Sections 14, 15 and 16 of the 18 river sections for which the Avon Waterways Committee (AWC) and the Water and Rivers Commission are developing recovery plans in conjunction with local communities.

The river section is shown on Map 3. It has a total length of approximately 40 km, and encompasses the following features:

- the junction of the main river channel with the outflow from the Yenyening Lakes, immediately below Qualandary Crossing;
- the confluence of the South Branch of the river, flowing down from Brookton;
- a series of river pools, linked by channel sections;
- two major tributaries entering from the east, Monjer-ducking and Turkey Cock Gullies and one minor tributary, Bally Bally Gully;
- bridged river crossings at East Kokeby Road and Yenyening Lakes Road, and minor rocky crossings within farming sections.

Along the bulk of this river section, the adjoining lands are broad-acre farming properties. Close to town there are smaller freehold residential blocks, farms, and parkland vested in the Shire of Beverley. The area was settled over 100 years ago and current land uses go back at least 60 years.

This section of the Avon River is degraded, and its once-beautiful pools are threatened. In addition to the rivercare objectives of AWC and WRC, there is significant Shire and local community interest in improving the river and its natural biodiversity and beauty.

1.2 Objectives of this Recovery Plan

The objectives of this plan are to

- establish a vision for the river, which provides a picture of how the river might look and our attitudes towards it in the future;
- identify the key issues which need to be tackled to assist recovery of the river in this section;
- develop practical local strategies which address the key issues and which will guide recovery of the river in the Kokeby section;
- assign priorities and responsibilities to proposed work;
- describe how it is intended that the plan be implemented, including the ongoing involvement of the Beverley community in rivercare work; and
- achieve the endorsement of the final plan by all other agencies and organisations who have the capacity to influence the recovery of the river.

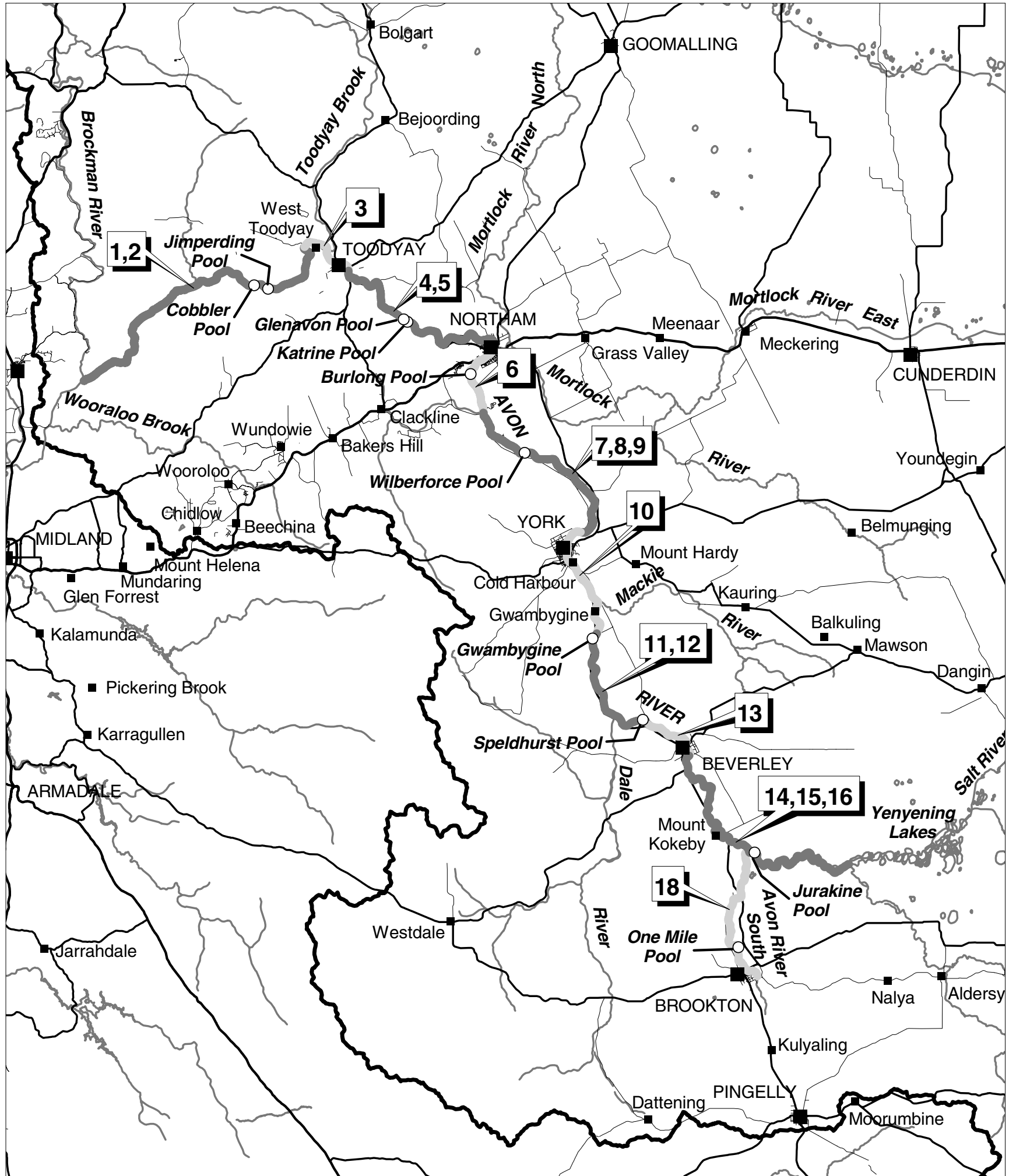
1.3 Why a Recovery Plan is needed

Before, and in the early days of European settlement, the Avon River in this area was mostly fresh, and was a place of beauty, teeming with wildlife. The river channels were braided, with many small channels interweaving between islands carrying thick stands of flooded gum and sheoak, and there were numerous deep, shady pools.

The river was a source of food and a profound spiritual resource to Aboriginal people and still forms part of a significant songline or dreaming trail.

After the settlement of Beverley district in the early 1830s, the river was used for domestic and stock watering, for picnics and for fishing and duck shooting. The pools were used as swimming holes on summer weekends. In some cases, the pools were used to wash sheep prior to shearing. The river is the central landscape feature of the Avon Valley.

AVON RIVER River Recovery Plan SECTIONS



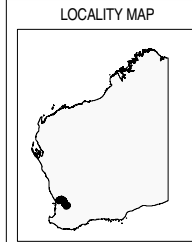
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LEGEND

- Towns
- Highway
- Main Roads
- Minor Roads
- Rivers - Lakes
- Avon River Sections
- 12 Section Number
- Pools
- Avon Avon River Catchment

N

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Water and Rivers Commission

This map is a product of Water and Rivers Commission, Regional Services Divison and was printed on 14.09.2001.
This map was produced with the intent that it be used for Avon River Recovery Plan at the scale of 1:750 000.
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Map 1: River Recovery Plan Sections

These values were largely intact until the 1950s, but have since been seriously degraded. This was caused by the impacts of settlement, unsound engineering practices and misuse. The two most serious issues still affecting the river are the results of the River Training Scheme (RTS) undertaken from the mid-1950s to the early 1970s and the inflow of salt and sediments from agricultural land. Other problems include: pollution, loss of riparian and aquatic ecosystems, weeds, rabbits, foxes and feral cats, the silting up of the pools and flooding of cropland.

In addition, a new generation has grown up, and is being followed by newer generations, who do not know or appreciate the way the river once was, and who take the existing degraded condition as normal.

The river will continue to degrade unless a new, shared, positive and achievable vision is recaptured for the river, by the community. This Recovery Plan is needed to help to promote and sustain this vision, as well as to set out a practical blueprint for local action.

1.4 The vision

The vision that underpins this Recovery Plan is to have once again *‘a clean river, free of pollutants, lined by robust native vegetation. The pools are deep and shady, and alive with birds, and are safe for swimming. Weeds, foxes, feral cats and rabbits have been largely controlled and there is no rubbish. The river and its tributaries are fenced to allow careful stock management, and fire hazards are under control.*

One area has been developed where the community can visit the river for relaxation, picnicking and enjoyment of the scenery and wildlife.

The local community takes a pride and feels ownership of its section of the river and is involved in its recovery and ongoing care and management.’

1.5 The planning process

In preparing this Recovery Plan, the following process was adopted:

- 1 A consultant was appointed to facilitate the planning process.
- 2 The Beverley Shire was briefed and their input obtained.
- 3 A public meeting was held in Beverley to outline the objectives of the plan, and to welcome community input.
- 4 An advisory committee was set up.
- 5 A draft plan was prepared and submitted to AWC/WRC and the local community for review.
- 6 Key organisations were identified and consulted during preparation of the plan. In addition to AWC/WRC, these included: the Shire of Beverley, Beverley bushfire interests, conservation interests, the Beverley Tourist Bureau, Aboriginal interests, and historical and heritage interests

Following endorsement by AWC and review by the Shire of Beverley, the Final Plan will be adopted by the Water and Rivers Commission, who will initiate implementation.

2 Background

2.1 The distinctive character of the Avon

The Avon River Basin is one of the major Australian river systems. It dominates the Central Wheatbelt of the Southern Land Division in Western Australia. The catchment of the Avon has an area of 120 000 km², which is larger than the area of Tasmania. It extends north of Wongan Hills, south of Lake Grace and east of Southern Cross. (See Map 2)

The Avon River Basin is also significant because it drains into the Swan-Canning Estuary, a central feature of Perth.

The Avon River differs to most river systems in other countries. Most rivers start in mountains or hills with high rainfall, and discharge to a drier coastal area with a low gradient floodplain or delta. On the contrary, the outer areas of the Avon basin have low rainfall and low landscape gradient. Both rainfall and gradient increase downstream.

The Avon River and the Swan River are in fact the same river. There is no 'confluence'. The two names simply represent an historical anomaly. The Avon is taken as that section of the river inland of the entry of the Woorloo Brook at Walyunga. The main waterway of the river is discernible upstream to Wickpin. The South Branch of the Avon River begins near Pingelly and flows through Brookton, joining the main river channel downstream of the Yenyening Lakes.

There are 15 major tributaries which flow into the Avon River downstream of the Yenyening Lakes.

2.2 River flow

The winter Avon usually commences to flow in April after the onset of winter rains and with falling temperatures and evaporation. In most years flow diminishes or ceases before Christmas. At Broun's Farm stream gauging station (between Beverley and York) the river flows on average for 286 days or 78% of the year. At Walyunga, where the Avon becomes the Swan River, the average flow is 310 days or 85% of the year. In a dry year, the river above Broun's Farm contributes only 12% of total river flow; in a wet year this can rise to over 40%.

The rate of flow of the Avon River is estimated to have increased by a factor of 3 to 4 since the River Training Scheme and the clearing of the catchment.

2.3 Floods and flood management

The major flood years last century were in : 1910, 1917, 1926, 1930, 1945, 1946, 1955, 1958, 1963, 1964, 1983 and 2000.

Flooding of riverside towns (Beverley, York, Northam and Toodyay) and of agricultural land along the river was the principal concern that led to the River Training Scheme (RTS) initiated by the State Government in the 1950s and 1960s. This involved:

- removal of channel vegetation and debris to a width of 60 metres;
- removal of dead trees, logs and debris which impaired the river flow;
- ripping of the river bed to induce erosion of a deeper watercourse;
- removal of minor kinks and bends in the river.

The success of the scheme in ameliorating townsite flooding is unresolved. No major floods have occurred since the works were undertaken. Rainfall has generally been lower than average over this period.

2.4 The inland catchments

There are three sub-catchments that make up the Avon River Basin: the Avon, the Yilgarn and the Lockhart.

The Yilgarn and Lockhart catchments, which drain into the Avon River through the Yenyening Lakes, have low or intermittent flow through drainage lines which usually comprise chains of shallow salt lakes. The contribution to water flow in the Avon River is generally less than 10% although the contribution of salt is high.



Map 2: Avon River Basin catchment

2.5 The river pools

There were originally 26 major pools in the Avon River (between Cobblers Pool and the Yenyening Lakes). These were up to 70 metres wide, varying in length from 370 metres to 2 kilometres, and some over 10 metres in depth.

In addition there were numerous minor pools and deep billabongs.

Most of the pools are now filled or are filling with sediment and are subject to eutrophication as a result of nutrient enrichment.

2.6 Biological diversity

A very high proportion of the Avon River Basin has been cleared of natural vegetation for agriculture. The original ecosystems are now represented by patches of bush in reserves or on farms in agricultural areas. Fringing vegetation of the Avon River, its tributaries and lakes provide a thin corridor for connection of these remnants.

The river is also significant in this altered landscape as summer and drought refuge for wildlife.

The river, and in particular the pools, have ecosystems that have adapted to fluctuating environmental conditions. However increasing salinity, sediments and nutrient enrichment or a changing flow regime threaten these systems.

2.7 River recovery and management

In the early 1980s, community concerns about the state of the river in the wake of the River Training Scheme resulted in the creation of the Avon River Systems Management Committee. This committee lobbied the State Government

and led to the formation of the Avon River Management Authority (ARMA) in 1993. Subsequently, ARMA prepared and published a Management Programme for the river, which sets out its strategies and priorities for river recovery and management. ARMA has now evolved to become Avon Waterways Committee.

One key strategy was to divide the river into 18 management sections, each of which could become the focus for detailed planning and recovery work. The Recovery Plan for Section 13 of the river from Beverley to Edwards Crossing arises from this strategy.

AWC is a community body, representing people and organisations along the river. River management is undertaken by the Water and Rivers Commission, a state government agency with professional staff and management resources. A key objective of the Recovery Planning process put in place by AWC is to build links between local communities, people living along the river, and government.

Several more Avon River Recovery Plans are now being prepared and are expected to be completed in 2002. This work is being funded jointly by the Water and Rivers Commission and the Natural Heritage Trust.

3 Issues

3.1 Key issues tackled in this Recovery Plan

During the preparation of this Recovery Plan, the following issues were identified as the most important for recovery of the Kokeby section of the Avon River.

- *The river pools:* There are 29 named pools in this section of the river. (see Map 3). A review undertaken as part of this planning process revealed that all are filled or are filling with sediments.
- *The river channels:* The river channels between the pools are degraded. These were scoured out and ripped by bulldozers during the River Training Scheme. This allows the river to flow rapidly between the channel banks (thus reducing the risks of floods), but the increased water velocity prevents the trapping of sediments outside the pools and the subsequent rebuilding of the riverbed.
- *Management of tributaries:* All the major tributaries of this section of the river are choked with sediment. This is steadily moving into the river. Sediment is also moving downstream from the South Branch and entering the river at the Ridgway and Smart farms. These sediments are filling the river pools, and directly affect drainage and flooding and have a secondary affect on salinity.
- *Fire:* There is a risk of bushfires within the river vegetation. Access to the river for fire control is limited, with only two all-weather crossings, and difficult access through farmland.
- *Stock in the river:* Grazing animals are able to enter the river in many places where fencing is absent or inadequate. Uncontrolled grazing leads to loss of bushland and riverbank erosion.
- *Salinity:* The river was once mostly fresh but became increasingly saline through the latter half of the 20th century. Salinity threatens many aspects of the river, including its ecology and aesthetics.
- *Education:* It is important to continue to raise the interest in and knowledge of the river in the community (especially people living in Beverley and along the river), and to encourage people to become involved in

river conservation and recovery work and to take a pride in the outcome.

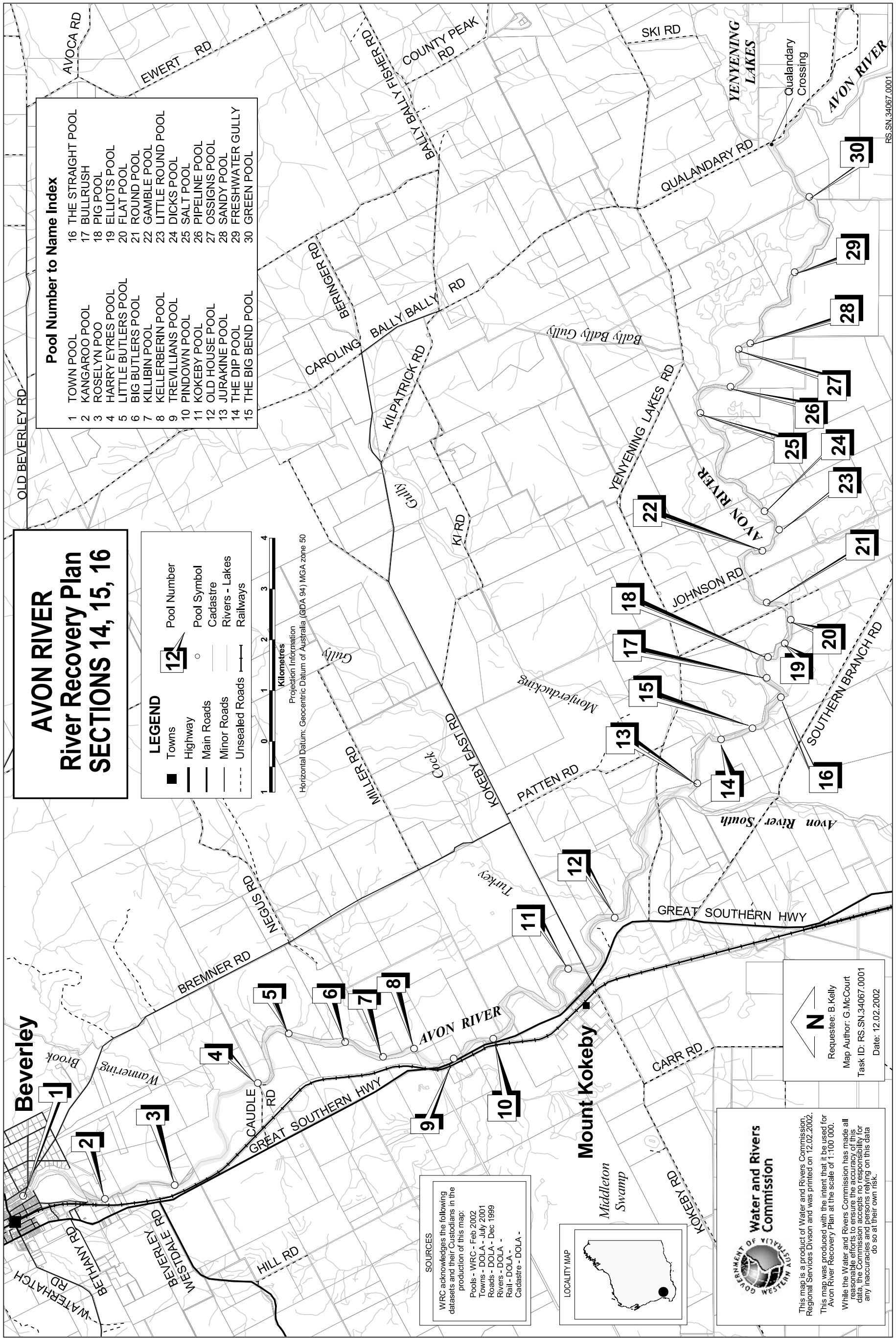
- *Recreation:* The river, or parts of it, can be incorporated into wider plans for tourism development in the Beverley area. There is also an opportunity to develop an area near the river which can be used as a bush picnic area.
- *Flooding:* After extreme rainfall events, the river leaves the floodway and flows out onto the floodplain, which is today occupied mostly by cropping land. Flooding like this is a natural process which has environmental benefits, but at the same time, flood waters can wash away topsoil or damage farming infrastructure, or drown stock.

3.2 Issues not addressed in this plan

A small number of river management issues were considered during the preparation of the Recovery Plan, but were deemed to be of low priority and therefore have not been addressed at this stage. These are:

- *Weeds:* Although weeds occur in and along this section of the river, they do not at this stage pose a serious threat to river recovery. The worst weed is wild oats, and the management of this species is dealt with under the heading of Fire Management.
- *Rubbish:* There are no serious accumulations of rubbish in the river along this section.
- *Chemical pollution:* There are no townsites and only limited human settlements along this section of the river. The main pollutants are organic matter (sheep faeces), and nitrogen and phosphorous in runoff from cropping areas. These are dealt with by strategies aimed at establishing effective vegetation buffers along the river and tributaries.
- *Wildlife conservation:* The recovery of wildlife along the river is dealt with indirectly by strategies aimed at controlling feral predators and other pests.
- *Pumping out of the river:* This is not regarded as a significant issue at this stage.

These lower priority issues will be reconsidered when this Recovery Plan is revised.



Map 3: Section 14, 15, 16

4 Proposed action

This section of the Recovery Plan describes the actions to be taken to address the key issues described above. Taken as a whole, these strategies will lead to the recovery of the Avon River Kokeby section.

Actions, responsibilities and priorities are summarised in section 7 of this Plan.

4.1 Recovery of the river pools

The goal is to rehabilitate and protect the pools on the river.

The pools are of major significance because they provide the summer refuge for aquatic life, and they are potentially such a fine aesthetic resource in the district. The pools were once deep, permanent and shady. Today they are silted up and polluted and their ecological value, water quality and aesthetics have declined.

There were once 29 pools on this section of the river. They varied in size from small billabongs and waterholes to great

pools over a kilometre in length, such as Jurakine and Eyres Pool. The former was once used for water skiing, but is now almost completely full of sediment.

It may never be possible to restore all of these pools. However there is strong community sentiment towards making a start. The two critical technical requirements are (i) disposing of current sediments from the pools and (ii) stopping the pools from refilling with new sediment. An over-riding consideration is funding to design and carry out the initial work, and to maintain it in the future.

Pool recovery and management is directly related to management of sediments movement in the river, discussed under 4.2 below.

Action to be taken:

In addition to the strategies outlined under Section 4.2, overleaf, the following strategies will be adopted:

- As an initial action, four pools are nominated for recovery action under this plan. These are Eyres Pool, Kokeby Pool, Jurakine Pool and Green Pool.



Jurakine Pool

Photo courtesy Phyllis Graham



Sediment slug approaching Eyres Pool

Photo courtesy Phyllis Graham

- For each of the four pools a small management plan will be prepared by experienced waterways engineers. The aims will be to increase summer water depth, improve water quality, improve and stabilise riparian vegetation and habitat, improve the aesthetics of the pools and their environs, and prevent the pools refilling with sediments. This will involve (where needed) detailed engineering surveys.
- Landowners adjacent to the pools will be briefed on the plans and their cooperation and assistance sought.
- Funds for pool rehabilitation and protection will be sought, including the involvement of corporate sponsors, especially from the mining and agribusiness industries.
- Work will commence on Green Pool as a ‘demonstration’ pool recovery project. Then in order of priority work will occur on Eyres Pool, Kokeby Pool and Jurakine Pool.
- When these pools have been recovered, a new priority list will be prepared and work will commence on these pools.

- Every pool management plan will be accompanied by a strategy for ongoing maintenance to prevent future decline and sedimentation.

WRC will plan and oversee pool restoration and management in consultation with the Shire of Beverley and local landowners. WRC will be responsible for all engineering works.

This work is high priority and should commence as soon as possible and then be ongoing.

4.2 Sedimentation of the river

The goal is to minimise sediments entering the river, to reduce the movement of sediments along the river, to stabilise the riverbanks and channels, and to remove sediments from the river at selected places.

There are three issues: the entry into the river system of new sediments from Monjerducking Gully, Turkey Cock Gully, Bally Bally Gully, and the South Branch of the Avon River; the loss of natural bedload sediments from the scoured river channels which were ripped by bulldozers

during the River Training Scheme; and the deposition of sediments into the pools. Minimising entry of new coarse sediments into the river is critical.

Sediments comprise heavy, coarse sands which are mostly rolled along by floodwaters, and finer silts and clays, which are carried in suspension in flowing river water. Both are moving down the river channels and are deposited where the river velocity is slowed, either by pools, a natural obstruction, or by the drying up of the river in summer.

A major cause of down-river sediment movement is the higher velocity of the river in the wake of the River Training Scheme.

This problem is being tackled elsewhere in part by the installation of ‘riffles’. In the context of this plan a ‘riffle’ is an engineer-designed, low rock bar placed across a waterway at a strategic point with the aim of slowing river velocity. These structures can also become places where coarse sediments are deposited and can be later removed. Each riffle is different, as it must be designed to fit the local situation. Riffles are most effective at low flow rates.

Movement of sediment into the river can be minimised by installing and maintaining ‘silt traps’ at the point of entry of a tributary.

The entry of new sediments from the South Branch of the Avon River, which enters the section covered by this Plan at Ridgway’s farm, has been addressed in a Recovery Plan for Section 18.

Actions to be taken:

- Priority will be given to reducing the entry of coarse sediments into the river. A survey will be carried out to confirm the major entry points. At these points, measures will be put in place to trap and remove sediment to minimise its entry to the river (see also Section 4.3, below).
- Riffles will be placed across the river at strategic points at the upstream boundary of the 4 pools listed for priority attention, with the aim of trapping sediment movement into the pools.
- Sediments accumulating at the foot of the riffles will be regularly removed.
- Landowners adjoining the river will be encouraged to maintain fences so as to assist revegetation along the river and the main tributaries entering this section of

the river. Riparian vegetation is an effective way of preventing new sediments entering streams.

- The Shire of Beverley will be requested to review the engineering of gravel roads leading down to the river to ensure no movement of sediment into the river.
- Where sediments removed from the river have commercial value, WRC will seek to return any income to the river for conservation and management works. Wherever practical and cost-effective, and with river neighbour agreement, sediment stockpiles will be developed on private land, rather than within the bushland along the river.
- All new engineering works likely to eventuate under this Plan will be discussed with the Shire of Beverley before commencement.
- Studies will be instituted into construction of minor riffles and other measures to slow the movement of the river along the scoured channels, and enable the riverbed to be rebuilt. A demonstration riffle will be constructed at an early date.
- Sponsorship will be sought.
- Riffles and sediment traps will be installed and sediment removal organised as soon as funds are available and engineering work plans approved.

Survey and engineering work will be undertaken by WRC with the cooperation of the Shire of Beverley and river neighbours.

4.3 Rehabilitation and management of the tributaries

The three main tributaries of the river in this section are Monjerducking Gully, Turkey Cock Gully and Bally Bally Gully. A third ‘tributary’ is the South Branch of the river; this is covered in a Recovery Plan for Section 18. There are a number of minor tributaries, generally without names, including the swampy drainage line running east and north of Kokeby townsite which flows into Kellerberin Lake (an ephemeral lake close to the Avon, just north of Kokeby).

The management of tributaries is critical, as they are the principal source of new sediment entering the river. However, any work on tributaries requires cooperation of landowners through whose land they flow.

**Monjerducking Gully***Photo courtesy Phyllis Graham**Actions to be taken:*

- Management of tributaries will be subject to a special review by WRC and local landowners. The purpose will be to develop practical strategies for their management and rehabilitation.
- Once the review has been completed and funds are available, work will commence on a program of tributary management. This might involve: (i) careful, localised removal of sediment from the watercourses, and trucking it away for stockpiling; (ii) construction of a silt trap at the foot of each stream, to be emptied of sediments on a yearly basis, or as required; (iii) fencing of the streams and revegetation of stream banks; (iv) installation of soil conservation measures in farm paddocks adjoining the streams; and (v) installation of riffles at intervals along the creeks to provide intermediate silt traps.
- As part of the work on restoring tributaries, alternative methods of disposing of sediments will be tested. These might include spreading it and keying it in to salt affected flats.

WRC will be responsible for initiating and leading the planning work in conjunction with catchment groups and landowners. Work will be carried out as funds become available.

4.4 Fire

The goals are to manage the fire problem along the river so as to minimise the threat to the river environment and to neighbours, and to educate river neighbours and encourage them to take responsibility for protecting their own assets.

Bushfire is a threat to the river environment and to river neighbours. Fire along the river results in loss of habitat (especially old trees), loss of rehabilitation plantings, soil erosion and increased weed growth. Fire escaping from the bushland can threaten life and community assets.

Bushfires are hard to tackle and to prevent in and along the river, because of poor access and heavy, grassy fuels. In addition, the river is a special problem because (i) it is a long linear corridor of bushland; and (ii) lengthy sections

are fenced off or are inaccessible to fire fighting vehicles. Exclusion of grazing will lead to increased amounts of grassy fuels, so these two issues must be co-managed.

High value areas adjoin the river, which are potentially threatened by bushfire. These include farm infrastructure, stock and cropland.

The principal fuels are wild oats and leaf and twig litter from native vegetation. Wild oats are enhanced by fire, but can be controlled (in the short term) by controlled grazing and (in the longer term) by shading out by a thick tree canopy.

In most of the entire length of this river section, access to the river bank for firefighters can only be achieved by entering and crossing private farmland.

AWC has a fire policy which sets out the objectives for bushfire management in and along the river. A coordinated approach to bushfire management along the river in the Beverley area is yet to be developed.

Actions to be taken:

- Burning of river bushland will be discouraged, and landowners along the river will be requested to ensure stubble burns do not run into the bushland along the river.
- A Handbook for River Neighbours will be prepared by AWC (in consultation with appropriate groups including the Shire) and issued to all river neighbours. In the section on fire, this will stress the responsibilities of landowners to take responsibility for protecting their own assets, and will explain the basis of fire management along the river.
- Landowners who wish to carry out controlled spring grazing of grass in the river will be encouraged to apply to WRC for permission. It is accepted that this may require additional fencing to control movement of stock up and down the river.
- Landowners along the river will be asked to install gates on fences along and at right angles to the river, so as to assist access for firefighters. Where this is done, a sign stating 'Fire Access Point' will be displayed on the front gate of the property.
- The Shire will be asked to prepare a Fire Management Plan for land under its control which adjoins the river. The purpose will be to set out measures for minimising the risk of bushfires burning into the river from Shire land, or threatening to damage assets on Shire land.

- Landowners adjoining the river who elect to install firebreaks, will be encouraged to keep them out of the floodway of the river, and to have trafficable tracks, rather than cultivated strips which would be subject to erosion.
- Western Power will be requested to review the safety of power lines running across river bushland.
- In the wake of a fire, prompt action will be taken to rehabilitate any new firebreaks and to ensure the burnt bushland is securely fenced to prevent stock grazing on natural post-fire regeneration.
- The Shire will be requested to upgrade the crossing at Green Pool to provide summer time access for fire-fighting vehicles.
- WRC will commence and maintain a database of fires, so that an accurate fire history for the riverland bush can be built up over time.

WRC and the Shire of Beverley will be responsible for convening the Bushfire Review each year, or as required, and for following up to see that action occurs. The Shire will be responsible for enforcement and fire management on its land. River neighbours will be responsible for protecting their own assets.

These initiatives should be developed during winter/spring following the final approval of this Recovery Plan. Henceforth, the action will be undertaken annually.

4.5 Salinity

The goal is to help minimise the salinity problem in the land adjoining the river.

The Avon River was always brackish in some years, but was mostly a fresh water river until about the middle of the 20th century. Since then it has become highly saline. This is basically a result of land clearing and farming practices on the catchment, although in some years saline water is delivered downstream when the inland salt lake system overflows.

Salinity threatens flora and fauna and also destroys the beauty of the river landscape.

Salt water is entering the Beverley-Yenyening section of the river from upstream, and also (to an unknown extent) from the tributaries and from movement of saline groundwater beneath paddocks being used for cropping and grazing. Currently late summer salinities in the pools

are significantly higher than that of seawater. The choking by sediment of the major tributaries of the river means that they are unable to rapidly carry away rainwater after a storm. This may lead to increased localised recharge of groundwater (which leads to lowland and stream salinity).

There are also some fresh water sources entering the river, usually associated with sandy soils.

The salinity problem is very large and complex, and cannot be resolved by isolated actions within one river section, but positive actions at the local scale can be taken.

Actions to be taken:

- AWC and WRC will support projects along the river which are designed to address the salinity problem, in particular the revegetation of bare hills (recharge areas) and of floodplains (discharge areas) along the river valley and on the catchments of the main tributaries.
- Landowners adjoining the river will be encouraged to maintain farming practices which minimise recharge and maximise freshwater runoff into the streams.
- Tributaries will be restored (see Section 4.3 above).
- Research into salinity management will be supported.

WRC will be responsible for liaison with and encouragement of landowners adjoining the river and tributaries.

4.6 Fencing and management of stock in the river

The goals are to have stock-proof fencing in place on both sides of the river along the whole length of the river from Beverley townsite to Yenyening Lakes; to have a Management Agreement with adjoining landowners so as to ensure fence maintenance; and to extend river fencing upstream along the tributaries into farming properties adjoining the river, especially Turkey Cock Gully and Monjerducking Gully.

Uncontrolled livestock grazing in the bushland along the river, or moving across the riverbanks and along the dry riverbed in summer can destroy native vegetation, introduce weeds, erode the river bank and river bed and pollute the river.

On the other hand, controlled grazing of bushland along the river can be used to reduce a serious fire hazard, and this can be approved by AWC. Controlled grazing requires fencing to confine stock to the approved grazing area and to control the intensity of grazing.

Over time, native species of trees and shrubs will regenerate behind fenced areas from which stock is excluded; alternatively these areas can be replanted with native trees and shrubs. The vegetation helps to control soil erosion along the river, acts as a trap for pollutants in runoff, and provides habitat for wildlife.

WRC provides fencing materials to qualifying landowners, in return for which the landowner is required to enter into an agreement about management of the fenced-off land which borders the river and management of the fence. This program is dependent on funding, and at the moment applies only to the main river, not to tributaries.

The current status of fencing along this section of the river was surveyed in March 2001. This survey determined that for the 41 km of river upstream of the Beverley town:

- Fenced both sides = 29.5 km
- Fenced one side = 9.5 km
- Fenced neither side = 2 km
- 24.5 km of existing fencing require maintenance/replacement in order to be stock (sheep) proof.

Actions to be taken:

- WRC will contact landowners on the reaches of the river which are not yet fenced, or where fences are not stock-proof as identified in the above survey, and will seek to enter into arrangements with them to complete river fencing on their properties.
- So long as fencing materials are available under current funding arrangements, they will be provided to river neighbours prepared to fence the river and enter into a Fencing Agreement.
- Where landowners cannot carry out fencing themselves, assistance will be sought from service clubs, etc.
- Over time, fence condition and fencing needs will be monitored and new or replacement fences organised as funds are available.
- Once the fencing of the main river is completed, priority will be given to fencing along the main tributaries, to allow regeneration and revegetation of the stream banks.
- Active revegetation of riparian zones inside fences will be encouraged, by the provision of advice, and organising volunteers to help with planting.

WRC will be responsible for all the above actions, and landowners will be responsible for fence repair and maintenance.



Fencing along the Avon River

Photo courtesy Martin Revell

The aim is to complete the actions listed above within 18 months of finalisation of this Recovery Plan.

4.7 Feral and pest animals

The goal is to minimise the number of feral and pest animals in bushland along the river.

Feral and pest animals were observed to be present in the bushland along the river. The main ones are foxes, feral cats and rabbits. Foxes and cats prey upon native fauna, while rabbits destroy native vegetation, or move out onto neighbouring properties as vermin, and make revegetation difficult.

Rabbits have been controlled on previous occasions, but have re-invaded and there has been some fox control by shooting. Naturalists from Beverley have undertaken programs of feral cat control by trapping.

Control of pest species is a community issue, requiring cooperative programs. Trapping and poisoning programs close to settlement have the additional risk of taking pets or farm dogs, which can cause ill-feeling. There are also

safety issues involved in the use of firearms or poisons, and control programs need to be responsibly organised and managed. The input of the Agriculture Protection Board (APB) is essential.

At the time of preparing this Plan, there have been unconfirmed reports of rare mammals in and along this section of the river, including the Red Tailed Phascogale. If these are confirmed by planned surveys, the habitat areas should become the special focus of fox control work, and this will be added as a new action step to the following.

Action to be taken:

- WRC will assist to develop cooperative arrangements between the Shire of Beverley, APB and landowners to institute control programs for feral and pest animals.
- Community groups and neighbours will be asked to note and report problems, such as rabbit burrows and high fox numbers.
- Priority will be given to controlling foxes and cats in river bushland in which native mammal species are found to occur.
- Trapping of feral cats will be encouraged.

4.8 Revegetation

The goal is to revegetate areas of the floodway of the river with native species, in order to stabilise the banks of the river, slow the velocity of floodwaters, and provide habitat for wildlife.

Most of the land along the river in this section is privately owned. Revegetation of private land is the responsibility of the landowner, but assistance can be arranged, especially to replant areas inside river fencing or to create linkages between patches of remnant vegetation.

Revegetation projects provide an excellent opportunity to involve Friends of the River and school children, or community work-order people.

WRC Northam has a specialist Revegetation Officer who is available to help plan and oversee projects.

Action to be taken:

- Riverside landowners and the Shire will be encouraged to set up revegetation projects along the river, with emphasis on linking remnant vegetation, or restoration of the river floodway.
- Community groups and schools will be invited to participate in revegetation work.
- Revegetation will combine trees and shrubs, and will use species endemic to the site.

4.9 Recreation

The goal is to provide a recreational opportunity on the river, which can be enjoyed by the public without deleterious impact on the river environment or neighbours.

Currently there are small numbers of people who walk along parts of the river, or who go bird-watching, but there is no place in this river section where people can picnic and enjoy the river environment. There are no developed facility areas. Access to the river by the public is impossible in most places, due to the land being privately owned. Boating and picnicking occurred in the past in places like Jurakine Pool, but this area is no longer attractive.

Action to be taken:

- The Shire will be asked to develop a picnic area on crown land vested in the Shire at Eyres Pool. This has excellent access, and is potentially a beautiful area. This should be done after the pool is restored. Development

could include picnic tables and gas BBQ, a car park, a walk trail along the river, toilets and signs or other interpretive material. Stock grazing should cease and be replaced by mowing, and the general area needs to be tidied up and new trees planted. Interpretive material should be made available to explain river management to visitors.

- The Avon Ascent will be asked to consider this site as part of their network, to encourage informed enjoyment of the river and environs.
- Sponsors will be sought to assist with funding for this development
- Outside this picnic spot, recreational visits to the river can only be made with the permission of landowners.
- WRC will suggest to landowners that activities in and along the river should be restricted to those which do no harm to the river and riparian areas. Examples of acceptable activities are walking, picnicking, canoeing, swimming, bird-watching, nature study, art, photography, and dog exercising.
- Landowners will be advised that the following activities are not considered acceptable within the river channel or along its banks: horse riding and off-road motorcycling or 4-wheel driving, and shooting (except for exotic pest or feral animal shooting undertaken as part of a managed pest-control program).

The Shire of Beverley will be asked to take responsibility for developing a new picnic area at Eyres Pool.

4.10 Education and communication

The goal is to ensure effective two-way communication between WRC/AWC and key audiences in the Beverley community.

The recovery of the river will be hastened if the local community understands the need to care for the river, shares a positive vision, and is prepared to contribute time, energy and funds to the needs of the river. Also, the community needs a forum in which it can pass on its concerns and achievements and local knowledge to the WRC/AWC.

Currently there is an inadequate understanding of Avon River issues in the Beverley community. Many young people or newcomers to Beverley accept the current degraded state as the normal state or have not had an

opportunity to become better educated about the river. Many other people have deep concerns, but feel powerless to change things.

Many members of the local farming community are supportive of river recovery work.

Action to be taken:

- An appropriate message will be developed for key audiences in the district, to be followed by a program of communicating these messages over time. Key audiences and messages are:

Key Audience	Key messages for these audiences
School children and young people	The natural history of the river, and the history of river use; the vision for the future; what is expected of them; what the rewards will be for them in the future; what they can do.
The Shire of Beverley	The expectation that they will incorporate this Recovery Plan into their overall planning schemes for the Shire.
Aboriginal people in Beverley	This Recovery Plan
Riverside neighbours	Their responsibilities in the areas of fire, stock control, fencing, soil conservation, waste disposal and chemical use, and acting as 'eyes and ears' of WRC/AWC with respect to river management issues.
Fire authorities	The contents of this Recovery Plan with respect to fire.
Tourist bureau and operators	This Recovery Plan

- Packages of educational material will be developed for insertion in curricula at the Beverley school, to enable teachers to deliver programs on river science, conservation and recovery.
- The Beverley School will be invited to undertake 'hands-on' projects relating to river restoration, including revegetation, monitoring, cleanup days.
- WRC will liaise with TAFE to see whether students who undertake voluntary river restoration projects can obtain credit for appropriate certificate courses.
- AWC will continue to support the Avon Ascent Program. This program is aimed at education of city people about landcare in the Avon River catchment, but also helps to educate local people through the information pillars at Avondale and the Town Pool.

- A Handbook for River Neighbours will be developed, covering issues in this Recovery Plan which are relevant to people living adjacent or near to the river. This will be distributed by WRC, and updated and redistributed from time to time. Cooperation will be sought from the Shire of Beverley and real estate agents to help with distribution to new residents along the river.
- WRC will be asked to prepared a coloured wall map of the river, showing features and names, for display in schools, homes and shops in Beverley.

WRC will be responsible for overall communication with key audiences, but will seek assistance from community groups and local people, including schoolteachers.

4.11 Flood mitigation

The goal is to minimise the impact of damaging floods on farmland on the floodplain, while maximising the environmental benefits of flooding in the bushland.

Almost every winter, the Avon River overflows its immediate channel, and in about one year in three it floods across the floodway and beyond.

There has been no serious flood damage along the river for many years. This is due to (i) below average rainfall since the 1950s; and (ii) the River Training Scheme which increased the depth of the river channel (thus increasing flood storage capacity) and opened up the bushland adjoining the river, thus minimising the frequency and duration of flood events. Higher water levels and flooding is considered to be more likely in the future if average rainfall patterns recover, and the clearing and channel deepening caused by the River Training Scheme is repaired. It will be essential that these changes be preceded by improved flooding preparedness along the river.

The most recent dramatic flood (following a summer rain event in January 2000) was classified only as a 1:20 year event in the main river channel. A 1:100 year event would clearly threaten houses on the floodplain, roads, crossings, stock and fences, and would cause severe soil erosion in paddocks along the river and its tributaries.

Annual flooding has environmental benefits. Inundation of bushland in the floodplain revitalises the native understorey species, helps to control wild oats, and promotes the regeneration of native vegetation. Prolific regeneration of swamp sheoak usually follows a flood. There are also adverse environmental affects caused by

flooding, including the mass movement of sediment down tributaries into the river where it is deposited in the pools.

Action to be taken:

- River neighbours will be advised of the risks that over-bank events may increase in frequency following river recovery work. They should flood-proof existing assets on the floodplain by the use of small-scale bunds and levee banks.
- The Shire of Beverley will be advised of the need for care in approving buildings on the floodplain.
- WRC will assist to develop and to promote adoption of an Avon River Flood Hazard Management Plan, including a public warning system.
- All river recovery work, such as installation of riffles and revegetation, will be reviewed in the light of their potential effect on flooding of private and public assets.
- Natural flooding will be encouraged on floodplains where no assets are threatened, to encourage natural regeneration and discourage weeds.

Flood mitigation planning is the responsibility of WRC and the Shire of Beverley, but river neighbours must expect to be subjected to occasional flood events and take responsibility for protecting their own assets.

4.12 Historic and heritage sites

The goal is to identify and preserve historical and heritage sites or features along the river.

No survey of historic sites along and adjoining the river has been carried out. Sites could include homesteads and river crossings.

Aboriginal people have strong associations with parts of the river comprising songlines or dreaming trails, and there may be other significant sites along the river. Details of sites of importance to Aboriginal people are normally not made public, but the need to ensure protection through a consultative process is important.

Action to be taken:

- The Shire of Beverley will be asked to organise a survey of the river and environs to identify all historic sites. This could be undertaken by the Beverley Historical Society.
- WRC will seek ways of supporting landowners who wish to protect such sites along the river.
- WRC will take all care to avoid damaging historic and heritage sites during river management work.
- WRC will consult with Aboriginal people in Beverley and will cooperate in protection of any sites or features of value to the Aboriginal people along the river.
- Aboriginal people will be asked to review proposed works, such as construction of ‘riffles’, before commencement, to ensure sites of significance are not disturbed.

5 Priorities

5.1 The two over-riding priorities

Most of the actions listed above can be carried out in parallel, with different people involved. However, the over-riding issue requiring investment of resources is the rehabilitation of the four nominated pools (Green, Eyres, Jurakine and Kokeby).

Associated high priority work will be the control and management of sediment moving into the river from Bally Bally, Turkey Cock and Monjaducking Gullies.

5.2 Other priorities

The other high priority tasks relating to the recovery of the Kokeby section of the Avon River are:

- 1 Educating and enthusing the Beverley community about river values in general and the specific needs for river recovery, promoting the new recovery plan and its policies and implementation and reporting to the community on programs and progress. This includes the development of a local Friends of the River group.

- 2 Putting in place a mechanism for dealing efficiently with the threat of bushfires.
- 3 Setting up revegetation and other projects in which the community can become involved.
- 4 Completing the fencing of the river.
- 5 Controlling feral and pest animals.
- 6 Develop the proposed new recreation site at Eyres Pool.

5.3 Priority ranking

In this plan the following terms apply:

- Very High Priority: important and urgent work; should commence at once.
- High Priority: important work but less urgent
- Medium Priority: important and not urgent
- Low Priority: less important and not urgent; can be deferred.

6 Implementation and review of the recovery plan

6.1 Primary force for promotion and oversight of the recovery plan

WRC, in conjunction with AWC, will provide the leadership necessary to drive the implementation of this Recovery Plan. They will do this through the development of positive, cooperative-operative arrangements between the following main groups:

- The Shire of Beverley
- River neighbours and the proposed ‘Friends of the River’ group.
- Bushfire personnel
- The Beverley Naturalists
- The Tourist Bureau
- The Historical Society
- Aboriginal groups
- The Avon Catchment Council
- Funding bodies within the Avon catchment and beyond
- Corporate sponsors.

The key role of WRC/AWC will be to bring the right people together on projects, to assist them to work cooperatively, to help capture expertise and funds, to oversee standards, and to report back on progress.

6.2 Involving the Beverley community in plan implementation

WRC/AWC will work with the local community to set up a Friends of the River group who can undertake projects arising from this and other Recovery Plans in the Beverley

area. The aim is to consolidate local pride and ‘ownership’ of the river and widen the net of resources and energy available for recovery projects.

A nucleus of interested people already exists in the form of people assisting with the development of this Recovery Plan, and the Recovery Plan for the river section downstream of Beverley.

At all times WRC/AWC will endeavour to keep the Shire fully informed about progress with river projects.

6.3 Plan review and reporting

Progress with the implementation of this recovery plan will be reviewed annually, and a report prepared for presentation to AWC. Articles on progress will be published in the local newspapers from time to time.

At approximately 5 years after its adoption, the plan will be completely reviewed, with the purposes of:

- Marking off work which is completed;
- Reconsideration of aspects of river management deferred in this plan;
- Adding in new work requirements, or amending strategies if needed;
- Reviewing priorities;
- Updating any other aspect of the plan.

The Beverley community will be asked to participate in this project. WRC/AWC will be responsible for triggering the review process and carrying it through to completion.

7 Summary of issues, actions, priorities and responsibilities

All proposed actions are subject to availability of funds, and the internal priorities of the organisations nominated.

The Issue	Action to be taken	Priority	Who is responsible
Recovery of river pools	<ul style="list-style-type: none"> Four pools nominated for initial action: Eyres Pool, Kokeby Pool, Jurakine Pool and Green Pool. Preparation of Pool Management plans. Briefing landowners adjacent to the pools. Acquiring funds for pool rehabilitation and protection, including contacting corporate sponsors. Commence work on Green Pool as a 'demonstration' pool recovery project. Commence on other three pools, as funds become available. ongoing maintenance of pools. 	Very High	<ul style="list-style-type: none"> AWC WRC/AWC WRC WRC/Shire/ Friends of the River WRC WRC WRC
Sedimentation of the river	<ul style="list-style-type: none"> Survey to confirm the major entry points and sources of sediment. Install riffles across the river at strategic points at the upstream boundary of the 4 pools listed above. Remove sediments accumulating at the foot of the riffles. Maintain fences so as to assist revegetation along the river and the main tributaries entering this section of the river. Review the engineering of gravel roads leading down to the river to ensure no movement of sediment into the river. Seek commercial return from sediments and return income to conservation and management works on the river. Develop sediment stockpiles on private land, with permission from owners, rather than within the bushland along the river. Discuss proposed engineering works with the Shire of Beverley before commencement. Institute studies into construction of minor riffles and other measures to slow the movement of the river along the scoured channels. Construct a demonstration riffle. Seek sponsorship. 	Very High	<ul style="list-style-type: none"> WRC/AWC WRC WRC/Shire Landowners Shire WRC//landowners WRC WRC/AWC/ Friends of the River
Rehabilitation of major tributaries	<ul style="list-style-type: none"> Review rehabilitation and management of tributaries. Develop practical strategies for their management and rehabilitation. Acquire funds for the work 	High	<ul style="list-style-type: none"> WRC WRC with expert assistance and landowner cooperation

Summary continued overleaf...

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The Issue	Action to be taken	Priority	Who is responsible
Fire	<ul style="list-style-type: none"> • Keep fire out of river bushland. • Develop and circulate Handbook for River Neighbours. • Encourage landowners who wish to carry out controlled spring grazing of grass in the river to apply to the WRC for permission. • Install gates on fences along and at right angles to the river, so as to assist access for firefighters. Where this is done a sign stating 'Fire Access Point' will be displayed on the front gate of the property. • Review Fire Break Order for properties adjoining the river, to require firebreaks to be trafficable to fire trucks. • Keep firebreaks out of the floodway. • Review the safety of power lines running across river bushland. • Rehabilitate any new firebreaks after a bushfire, and ensure the burnt bushland is fenced. • Upgrade the crossing at Green Pool to provide summer time access for fire-fighting vehicles. • Maintain a database of fires in the river. 	High	<ul style="list-style-type: none"> • Landowners • AWC • WRC/AWC • Landowners • Shire • Landowners • Western Power • Landowners • Shire • WRC
Fencing and management of stock in the river	<ul style="list-style-type: none"> • Contact landowners and arrange to complete river fencing on their properties. • Provide materials to river neighbours prepared to fence the river and enter into a Fencing Agreement. • Monitor fence condition and fencing needs. • Encourage fencing of the main tributaries. • Revegetate riparian zones inside fences 	High	<ul style="list-style-type: none"> • WRC • WRC • Landowners and WRC • WRC/AWC • Landowners, Friends of the River
Control feral and pest animals	<ul style="list-style-type: none"> • Develop cooperative arrangements between the Shire, APB and landowners to institute control programs for feral and pest animals. • Encourage community groups and neighbours to note and report problems, such as rabbit burrows, high fox numbers. • Give priority to controlling foxes and cats in river bushland in which native mammal species occur. Trap feral cats. 	Medium	<ul style="list-style-type: none"> • WRC • Landowners, Friends of the River • Landowners, Friends of the River, Beverley Naturalists
Revegetation	<ul style="list-style-type: none"> • Select sites for revegetation projects. • Involve community and school. 	High	<ul style="list-style-type: none"> • Landowners and Shire of Beverley • Friends of the River, WRC
Recreation	<ul style="list-style-type: none"> • Develop a picnic area on crown land vested in the Shire at Eyres Pool. • Request Avon Ascent to consider this site as part of their network. • Seek sponsors to assist with funding for this development. • Suggest appropriate and inappropriate recreational activities on river on private land to landowners. 	Medium	<ul style="list-style-type: none"> • Shire • AWC • Shire, Friends of the River • WRC
Education and communication	<ul style="list-style-type: none"> • Develop an appropriate message for key audiences in the district. • Institute a program of communicating these messages. • Develop packaged educational material for insertion in curricula at the Beverley school. • Support the Avon Ascent Program. • Develop Handbook for River Neighbours covering issues in this Recovery Plan relevant to people living adjacent or near to the river. 	High	<ul style="list-style-type: none"> • WRC/AWC • WRC/AWC • WRC and teachers • AWC • WRC/AWC

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The Issue	Action to be taken	Priority	Who is responsible
Flood mitigation	<ul style="list-style-type: none"> • Advise river neighbours of likely increase in flooding. • Flood-proof assets on the floodplain. • Take care before approving buildings on the floodplain. • Develop and promote Avon River Flood Hazard Management Plan and public warning system. • Review potential impact of river recovery work on flooding. • Encourage flooding where no assets are threatened. 	Medium	<ul style="list-style-type: none"> • WRC • Landowners • Shire • WRC • WRC • WRC/AWC
Conserve historical and heritage sites	<ul style="list-style-type: none"> • Survey the river and environs to identify all historic sites. • Support landowners who wish to protect such sites along the river. • Protect historic and heritage sites during river management work. • Consult with Aboriginal people in Beverley and cooperate in protection of any sites or features of value to the Aboriginal people along the river. • Review proposed works, such as construction of 'riffles', before commencement, to ensure sites of significance are not disturbed. 	Medium to High	<ul style="list-style-type: none"> • Shire and Historical Society • WRC • WRC • WRC/AWC • Beverley Aboriginal community
Implement this Recovery Plan	<ul style="list-style-type: none"> • Provide leadership. Establish Friends of the River group. • Bring expertise to bear on issues. • Keep Shire and local community informed. • Review and update plan 	Very High	<ul style="list-style-type: none"> • WRC/AWC

Appendix one

Management sections of the Avon River

Section Name	Section Number	Description	Length (km)
Cobblers Pool	1	Upstream from Avon Valley National Park to confluence with Jimperding Brook	11.23
Deepdale	2	Confluence of Jimperding Brook to Crossing of Deepdale Road	8.14
Toodyay	3	Deepdale Road to Goomalling Road Bridge, including all of Toodyay Town upstream of the bridge on the south bank of the river	9.16
Extracts	4	Goomalling Bridge to Glen Avon Weir	11.3
Katrine	5	Glen Avon Weir to Northam Town Weir	17.45
Northam	6	Northam Town Weir to confluence with Spencer's Brook	10.13
Muresk	7	Spencer's Brook to Wilberforce Crossing	8.75
Wilberforce	8	Wilberforce Crossing to Burges Siding	9.08
York	9	Burges Siding to Balladong Road Bridge	12.05
Cold Harbour	10	Balladong Bridge to Gwambygine East Road	11.40
Gwambygine	11	Gwambygine East Road to Oakover Crossing	5.83
Dale River	12	Oakover Crossing to Edwards Crossing	12.09
Beverley	13	Top Beverley Road to Beverley Town Pool	6.81
Kokeby	14	Beverley-Mawson Road Bridge to confluence with Avon River South Branch	21.67
Jurakine	15	Avon River South Branch to Johnson Road	5.51
Qualandary Crossing	16	Johnson Road to Qualandary Crossing	12.17
Yenyening Lakes	17	Upstream from Qualandary Crossing	Indeterminate
Brookton	18	Confluence Avon River South Branch to Brookton Townsite	18.46

Appendix two

Major confluences and pools for each section of the Avon River

Section	Confluences	Pools
1	Julimar Spring (3.0), Mortigup Brook (6.5), Munnapin Brook (8.0), Malkup Brook.	Cobbler (9.0), Long (10.5 - 11.0).
2	Jimperding Brook (2.5).	Diving (2.5 - 3.0), Deepdale (8.0 - 8.5).
3	Toodyay Brook (5.0), Boyagerring Brook (8.5).	Nil
4	Harper Brook (aka Seven Springs) (2.5).	Lloyds (2.0), Millard (3.0 - 5.0).
5	Mistake Creek (4.0), Wongamine Brook (13.5), Mortlock River (17.5).	Glen Avon (0.5 - 1.5), Katrine (5.5 -6.5), Egoline (7.5 - 8.5).
6	Spencers Brook (6.10).	Northam (0.5 - 1.0), Burlong (4.3 - 5.0).
7	Heal Brook (7.0).	Wilberforce (7.5).
8	Salmon Gully (5.0).	Mackie (3.5 - 4.0), Tipperary (8.5).
9	Nil	Tipperary (0.5 - 1.0), Meares (3.5), 5 Mile (?), York 1 Mile (9.5), York Town (11.0)
10	Bland Brook (0.5), Mackie River (6.5).	Mt Hardy (2.5), Cold Harbour (4.0).
11	Nil	Gwambygine (1.0 - 1.5), Oakover (also known as Fleays) (5.5).
12	Dale River (6.5).	Yangedine (aka Avondale or Broun's) (4.5), Seaton Ross (aka Robins) (10.0 - 10.5).
13	Nil	Beverley (0.5), Speldhurst (2.0).
14	Wannering (6.0).	Eyres (6.5 - 7.0).
15	Turkey Cock Gully (1.5), South and Eastern Branches of the Avon River (5.0), Monjerducking Gully (6.0).	Nil
16	Bally Bally Gully (6.0).	Nil
17	Separate assessment	Separate assessment
18	Mangiding Brook (8.5).	Nil

Note:

The number in parenthesis refers to the distance (in kilometres) at which the confluence or pool is located from the downstream boundary of each section.

Appendix three

Summary survey information for River Sections 14, 15 and 16

(Information contained in *Avon River Survey Volume 2: Section Condition Summaries and Condition Matrices*, an unpublished report prepared by Ecoscape (Australia) Pty Ltd and Jim Davies and Associates Pty Ltd for the Avon Waterways Committee, 1996)

SUMMARY FOR SECTION 14 Beverley Mawson Bridge to confluence with Avon River South Branch (length: 21.67 km)

I Main Overstorey Species Present

All three overstorey species are present throughout the section, but the *Eucalyptus rudis* and *Melaleuca raphiophylla* are dominated by *Casuarina obesa* at virtually every transect section. *Eucalyptus rudis* is present at every transect, usually on both banks, but sometimes present on only one bank. It is always found as a woodland, except for transect 14/6.5 where it is present as a closed forest on the right bank and an open forest on the left bank, and dominates the overstorey. *Melaleuca raphiophylla* is present at many of the transects, but at some transects it is absent from one or both banks (14/0.5, 14/2.0, 14/3.0-14/6.0, 14/7.0-14/8.0, 14/10.5, 14/11.0, 14/12.0-14/13.0, 14/14.0-14/15.5).

II Vegetation Death

Nearly half of the transects surveyed in this section had a significant level of vegetation death recorded. These were transect numbers 14/0.5-14/2.5, 14/3.5, 14/4.0, 14/6.5-14/8.0, 14/11.0 and 14/13.5 inclusive. Vegetation death was more apparent, it was usually the *Eucalyptus rudis* and *Melaleuca raphiophylla* which were dead or dying. At some of the transects where heavier salt concentrations were observed, the individuals of *Casuarina obesa* are also dead or dying (14/1/0, 14/1.5 and 14/2.5).

III Fencing

Most of the transects in this section were fenced on both banks, and approximately one third were fenced on only one side of the riparian zone (14/1.0, 14/3.0, 14/3.5, 14/6.5, 14/7.0, 14/10.0, 14/11.0, 14/13.0-14/14.0). There are only two transects in this section which did not have the riparian vegetation fenced off (14/0.5 and 14/2.5). Most of the fencing present was in a good-medium condition, but some was also in a medium-poor condition (14/5.5, 14/6.0, 14/7.0, 14/8.5, 14/11.5, 14/12.5, and 14/14.5-14/15.5).

IV Other Native Species Present

The native understorey species present which act to stabilise the rivers banks are: *Atriplex prostrata*, *Frankenia pauciflora*, *Sarcocornia quinqueflora* and *Sporobolus virginicus*. *Juncus pallidus* is also present on the banks. The other species present as components of the overstorey are: *Acacia acuminata*, *A. saligna*, *Astartea fascicularis*, *Banksia prionotes*, *Baumea articulata*, *Eucalyptus loxophleba*, *E. salmonophloia*, *E. wandoo*, *Grevillea alabrata*, *Hakea preissii*, *Hakea spp.*, *Jacksonia sternbergiana* and *Xanthorrhoea preissii*. At transect number 14/2/5 at the top of the left bank there is an access roadway with native vegetation beyond it. Growing in this area of native vegetation were *Banksia prionotes*, *Eucalyptus loxophleba*, *Grevillea glabrata*, *Hakea spp.*, *Jacksonia sternbergiana* and *Xanthorrhoea preissii*. In this area, the soil was sandy and there was no evidence of water logging.

V Weed Species Present

Annual grass species were present throughout this section as well as: Perennial wild melon (*Citrullus colocynthis*), Corn Gromwell (*Buglossoides arvensis*), Spiny Rush (*Juncus acutus*), Cape Lilac (*Media azedarach*), Soursob (*Oxalis pes-caprae*), Sorrel (*Rumex acetosella*) and an unidentified succulent weed in the *Amaranthaceae*.

VI Vegetation Condition

(according to the 1995 Pen and Scott (1995) assessment for the condition of river bank vegetation).

Approximately half of the transects in this section were given a vegetation condition rating of B3-C1, indicating that the understorey was comprised only of weeds and there was no surface erosion present. These were transect numbers 14/1.0, 14/2.0, 14/3.0, 14/4.0, 14/6.0, 14/9.0, 14/13.0, 14/14.0). The remaining transects were rated as either B2-B3 which meant that at these sections there was an understorey comprised of mainly weeds, but with some native species growing amongst the weeds, or rated as C1-C2 indicating that all understorey species were weeds and there was some exposed soil due to surface erosion. Transect numbers 14/0.5, 14/1.5, 14/2.25, 14/3.5, 14/6.5-14/8.5 and 14/5.0 were given a vegetation condition rating of B2-B3, and transect numbers 14/13.5, 14/4.5, and 14/15.5 were given the vegetation condition rating of C1-C2.

VII Regeneration

Eucalyptus rudis had a nil regeneration at most transects in this section, and few had a low level of regeneration (14/0.5, 14/1.5, 14/6.0, 14/6.5, 14/9.5, 14/11.0, 14/2.0, 14/13.0-14/15.5). Almost all transects surveyed showed a nil regeneration for *Melaleuca raphiophylla*, except for transect numbers 14/2.5, 14/7.5, 14/8.5, 14/10.5, 14/11.5, 14/12.0, and 14/13.5 which showed a low rate of regeneration (1-100 plants/ha). *Casuarina obesa* had a medium rate of regeneration over all transects (100-500 plants/ha, with few transects showing low regeneration and a few showing high regeneration. Nearly all regenerating individuals at all transects except for an even aged stand of *Casuarina obesa* at transects 14/9.5 and 14/15.5. There was also an even aged stand of *Eucalyptus rudis* growing at transect number 14/13.0.

VIII Disturbance Factors

Transect numbers 14/11.0 to 14/15.5 inclusive showed evidence of livestock (sheep only) in the river and grazing the riparian vegetation. The presence of feral animals (foxes and rabbits) was noted at many of the transect sections. Transect numbers 14/1.0, 14/1.5, 14/8.9, 14/11.0, 14/13.0, and 14/15.0, showed presence of foxes (fox dens) and transect numbers 14/5.0, 14/8.0, and 14/14.0 showed the presence of rabbits (rabbit warrens). Rubbish dumping was seen at four transects in this section; 14/2.0, 14/9.5, 14/12.5, and 14/14.5. Service corridors beside and/or across the main channel were present at three transects in this section; 14/1.5,-14/2.5 inclusive. Another possible source of disturbance at transects 14/7.5 and 14/8.9 was the presence of kangaroos in the riparian zone. The banks at transect numbers 14/2.0, 14/4.0, 14/5.0, 14/6.0 and 14/10.5 seem to have had their overstorey vegetation cleared as evidenced by the remnant, dead, large tree trunks and root masses.

SUMMARY FOR SECTION 15 Confluence with Avon River South Branch to Johnson Road (length: 5.51 km)

I Main Overstorey Species Present

This is a very degraded section with lots of dead overstorey vegetation at most of the transects. Most of the transects in this section did not have *Eucalyptus rudis* or *Melaleuca raphiophylla* present, and the few individuals of these two species which were present were dead or dying. There were no individuals of *Eucalyptus rudis* seen at transect numbers 15/0.5, 15/2.0, 15/3.0, 15/4.0, 15/5.0, 15/5.5, 15/6.5-15/8.5, 15/9.5 and 15/10.0. There were no individuals of *Melaleuca raphiophylla* seen at transect numbers 15/0.5-15/4.0 and 15/5.0-15/10.0. *Casuarina obesa* was the only overstorey species that seems to survive at this section. It dominated at transect numbers 15/0.5-15/5.5 and 15/9.5.

II Vegetation Death

Approximately seventy five percent of the transects in this section showed a significant level of vegetation death. The only transects that did not have a high level of vegetation death were numbers 15/1.5, 15/2.5, 15/3.0, 15/4.5 and 15/5.0. It is mostly *Eucalyptus rudis* and *Melaleuca raphiophylla* which are dead, but in the latter sections (15/5.5 onwards) where there was higher visible presence of salinity and all vegetation was dead and dying, including *Casuarina obesa*, other native species and weed understorey species.

III Fencing

Half of the transects in this section were fenced on both banks (15/0.5-15/3.0 and 15/4.5-15/6.0) only two transects were fenced on only one bank (15/3.5 and 15/4.0) and the remaining transects were not fenced on both banks (15/6.5-15/10.0). The fences present at the fenced off transects were all in a good condition.

IV Other Native Species Present

The native understorey species present which act to stabilise the rivers' banks are: *Atriplex prostrata*, *Frankenia pauciflora*, *Sarcocornia quinqueflora* and *Sporobolus virginicus*. The other species present composing the overstorey are: *Acacia acuminata*, *A. saligna*, *Banksia prionotes*, *Dryandra sessilis*, *Eucalyptus loxophleba*, *E. Salmonophloia*, *E. wandoo*, *Hakea preissii*, *Jacksonia sternbergiana*, a species of *Cassytha* parasitising *Casuarina obesa* (*Cassytha glabella*), *Leptospermum erubescens*, *Melaleuca cuticularis* and *Melaleuca preissiana*.

V Weed Species Present

Annual grass species were present throughout this section as well as: Spiny Rush (*Juncus acutus*), Soursob (*Oxalis pes-caprae*), Corn Gromwell (*Buglessoides arvensis*) and an unidentified succulent weed in the *Amaranthaceae*. Saltwater Couch (*Paspalum vaginatum*) was also present with the other native understorey species growing on the river bank.

VI Vegetation Condition

(according to Pen and Scott (1995) assessment for the condition of river bank vegetation).

Four transects (15/0.5-15/1.5 and 15/7.5) were rated as B2-B3, indicating that the understorey was mostly weed species but also had native species growing amongst them. Four transects (15/7.0 and 15/9.0-15/10.0) were rated as C1-C2, indicating that all understorey species were weed species but also had native species growing amongst them. Four transects (15/7.0 and 15/9.0-15/10.0) were rated as C1-C2, indicating that all understorey species were weeds and there was some exposed soil due to surface erosion. There was also one transect which was given a vegetation condition rating of C2-C3 (15/6.5), indicating total domination of the understorey by weed species and more extensive erosion of the river banks than previously seen (not just surface erosion but also lower layers in the soil profile). The remainder of the transects had a vegetation condition rating of B3-C1 (the majority).

VII Regeneration

Both *Eucalyptus rudis* and *Melaleuca raphiophylla* had nil regeneration at nearly every transect in this section. Transect numbers 15/1.0, 15/2.5, 15/2.0, 15/4.5, 15/5.0 and 15/5.5 had only low regeneration (1-100 plants/ha) for these two species. *Casuarina obesa* was again seen to have the highest rate of regeneration of all three overstorey species. It was classed as having a medium rate of regeneration (100-500 plants/ha). All regenerating individuals at all transects formed mixed aged stands.

VIII Disturbance Factors

Many of the transects in this section had livestock present in the river channel and grazing the riparian vegetation. Sheep were the only type of livestock seen in this section, and they were present at transect numbers 15/1.5, 15/2.5-15/5.0, 15/6.0-15/8.0, 15/9.0 and 15/10. Feral animal presence (fox dens) was observed at transect numbers 15/1.0, 15/3.5 and 15/5.0. At transect number 15/5.0 there was also visible evidence of rabbits. Rubbish dumping (an old car body) was seen at transect number 15/1.5, but no other evidence of rubbish was visible in this section.

SUMMARY FOR SECTION 16 Johnson Road to Qualandary Crossing (length: 12.17 km)

I Main Overstorey Species Present

There is not much overstorey of any sort at most of these transect sections, especially *Eucalyptus rudis* and *Melaleuca raphiophylla*. *Casuarina obesa* dominates only a few of the transects in this section, these are transect numbers 16/3.5, 16/5.0, 16/7.0, 16/8.0, 16/8.5 and 16/10.0. Both *Eucalyptus rudis* and *Melaleuca raphiophylla* were absent from transect numbers 16/0.5-16/3.0, 16/5.0-16/7.0, 16/8.5-16/10.0 and 16/11.0-16/12.0. *Melaleuca raphiophylla* was further absent from transect numbers 16/3.5-16/4.5, 16/7.5 and 16/8.0.

II Vegetation Death

There was a significant level of vegetation death recorded at most of the transects in this section. These were transect numbers 16/0.5, 16/6.0, 16/7.0, 16/8.5-16/9.5 and 16/11.0. It was *Melaleuca raphiophylla* which was the species consistently seen dead or dying at all the transect sections. There was also a high incidence of *Eucalyptus rudis* death at most of the transects surveyed. *Casuarina obesa* was not seen to be dying at this section.

III Fencing

All transects in this section had fencing present on at least one of the banks. Transect numbers 16/0.5, 16/1.0, 16/2.0, 16/4.5, 16/6.0, 16/6.5, 16/11.5 and 16/23.5 were fenced on both banks, and the remaining transects were fenced on only one side of the main channel. All the fences present, lining the riparian zone, were in a good to medium condition.

IV Other Native Species Present

The native understorey species present which act to stabilise the rivers' banks are: *Frankenia pauciflora* and *Sarcocornia quinqueflora*. *Juncus pallidus*, is also present on the banks. The other species present composing the overstorey are: *Acacia acuminata*, *A. saligna*,

Allocasuarina humilis, *Astartea fascicularis*, *Banksia prionotes*, *Dryandra* spp., *Eucalyptus loxophleba*, *E. salmonophloia*, *E. wandoo* parasitised by *Amyema miquelii*, *Hakea preissii*, *Isospogon* spp., *Melaleuca cuticularis*, *Melaleuca preissiana*, *Verticordia* spp. And *Xanthorrhoea preissii*. (Also quite a few other species to still identify from this section). Transect number 16/7.0 has an area of sandy-loam soil on both banks with many species growing on the right bank which have mostly not been present previously. These species are able to grow on sandy soils, but have not been seen on the alluvial clays which characterise the soils of the riparian zone.

V Weed Species Present

There were only annual grass species present throughout this section and also Soursob (*Oxalis pes-caprae*).

VI Vegetation Condition

(according to Pen and Scott (1995) assessment for the condition of river bank vegetation).

Nearly half of the transects in this section were given a vegetation condition rating of B3-C1, indicating that the understorey was only weeds and there was no surface erosion present. These were transect numbers 16/2.5-16/5.0, 16/7.0, 16/8.5, 16/9.5, 16/12.0 and 16/12.5. There were also quite a few transects which were rated as B2-B3 for vegetation condition, indicating that the understorey was composed of weeds mostly but there were also native understorey species present amongst them. Transects given this rating were 16/0.5 = 16/2.0 and 16/10.0-16/11.5. The remaining transects were the most degraded in this section, and these were given a vegetation condition rating of C1-C2. These were transect numbers 16/5.5-16/6.5, 16/7.5, and 16/9.0. A rating of C1-C2 indicated that the understorey is composed solely of weed species and there is some exposed soil due to surface erosion.

VII Regeneration

There was very little regeneration of *Eucalyptus rudis* at most transects in this section. Only a few transects (16/4.5, 16/6.5, 16/8.0, 16/9.0, 16/10.0, 16/11.0, 16/12.5) has a low regeneration rate (1-100 plants/ha) for this species. The rest of the transects showed a nil regeneration rate for this

species. There was no regeneration of *Melaleuca raphiophylla* at any of the transects in this section. The regeneration rate of *Casuarina obesa* which was successfully regenerating at the previous transects, was low (1-100 plants/ha) at this section. All regenerating individuals at all transects formed mixed aged stands except for one young stand of *Eucalyptus rudis* at transect 16/12.5 which formed an even aged stand.

VIII Disturbance Factors

There were many disturbance factors present at this section, the largest one being the presence of livestock in the river

and the riparian zone. The livestock present in this section of river was only sheep, and they were present at transect numbers 16/0.5 and 16/1.5-16/10.0. There was also rubbish dumped at transect numbers 16/1.5, 16/2.0, 16/4.0 and 16/6.5. Service corridors beside and/or across the main channel were present at two transects: 16/4.5 and 16/6.5. The presence of feral animals was recorded at five transect sections. Fox presence was seen at 16/2.0 and rabbit presence was seen at 16/5.0, 16/5.5, 16/7.0 and 16/10.0. Evidence of fire on both banks was seen at transect numbers 16/12.0 and 16/12.5. Another possible source of disturbance was the presence of kangaroos in the riparian zone at transects 16/8.5 and 16/10.0-16/12.5.

