Department of Water
Government of Western Australia

River Recovery Plan, Foreshore and Channel Assessment

Section 19 – Aldersyde-Kweda

River Recovery Plan Series

REPORT NO. RRP 11
DECEMBER 2006

Department of **Water**
Government of **Western Australia**

River Recovery Plan, Foreshore and Channel Assessment

Section 19 – Aldersyde-Kweda

AVON CATCHMENT COUNCIL

Australian Government

Government of Western Australia

Prepared by
Viv Read & Associates
for Department of Water and
the Avon Waterways Committee

Jointly funded by
Department of Water,
Avon Catchment Council,
Natural Heritage Trust and
National Action Plan for Salinity and Water Quality

Department of Water

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Acknowledgements

The Aldersyde-Kweda Section Recovery Plan has been prepared with considerable local contribution from Lindsay Eva, Kim Mills and Kevin White (the interim Steering Committee).

Others who have contributed locally to the plan through meetings and workshops were Ingrid Bell, Shane and Karen Bowron, Robin Campbell, Don, Gary and Anne Eva, Jan and Michael Eva, Kevin Lee, Colin and Brad Mills, Ruth Owen, Darrell and Suzanne Turner, Stuart and David Watson and Kevin White.

Bernard Kelly (Department of Water, Northam Office) provided direction and management for the project. Kate Gole, Rachael Major (Department of Water, Northam Office) and Hamish West (Department of Water, Regional Support) prepared map information. Tim Emmott (Greening Australia, WA) contributed at workshops and arranged a bus tour (8 August 2005) of demonstration farm forestry.

Viv Read (Viv Read & Associates) undertook the survey and planning processes and prepared the draft Recovery Plan. All photographs taken by Viv Read, unless otherwise stated.

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Recommended reference

The recommended reference for this publication is Department of Water 2006. River Recovery Plan, Foreshore and Channel Assessment: Aldersyde-Kweda Section 19. Report No RRP 11. Prepared by Viv Read and Associates.

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Printed on recycled stock

December 2006

ISSN: 1441-5208

Cover photograph: Upper Avon River
V. Read

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Abbreviations

ACC	Avon Catchment Council
AWC	Avon Waterways Committee
CALM	Department of Conservation and Land Management
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DAWA	Department of Agriculture WA
DoE	Department of Environment
DoW	Department of Water
WRC	Water and Rivers Commission

Preface

The Aldersyde-Kweda section of the Upper Avon River extends from the Yenyening Lakes upstream to Squires Road, a stream channel distance of 60 km. The headwaters of the Avon River are the Yealering Lakes system located further upstream. This Recovery Plan is for the Aldersyde-Kweda section of the Avon River. It includes information derived from a river survey for this section and from planning processes with neighbouring landholders.

The purpose of the river survey and recovery plan is to provide management guidelines and a set of proposed actions for the river. Management is required in response to many processes that currently threaten the health of the river system. Salinity and increased stream flow causing erosion and sedimentation are two of the key threats to the river.

The Recovery Plan has been initiated by the Department of Water (formerly Department of Environment) but is intended for adoption by those who live and work by the river and many others with an interest in river management. The Department of Water, in partnership with the Avon Catchment Council, will provide opportunities for partnership arrangements for implementing the actions. Funding for the survey and planning processes has been provided under the Commonwealth and State Government investment initiatives for natural resource management directed through the Avon Catchment Council.

The survey and recovery planning for the Aldersyde-Kweda section of the Avon River was undertaken during 2005. The actions of the plan are intended for implementation over the coming 3-5 year period with an expectation that they will achieve change in the river environment as perceived within the local Vision for the river in about 20 years from now.

Bernard Kelly
Senior Natural Resource Management Officer

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Swan-Avon Region
Northam Office

1 Introduction

1.1 Managing the Avon River

The Avon River is one of Western Australia's major river systems. It provides natural drainage for the extensive Avon River Basin which stretches from Dalwallinu in the north, Southern Cross in the north-east and Lake King in the south east – a total area of approximately 120 000 km². The Avon discharges to the Swan-Canning estuary near Perth.

One branch of the Avon River, known as the Upper Avon River, originates within the Shire of Wickepin. The catchment area upstream of the confluence with the Salt River at Yenyening Lakes is 3 200 km^2.

Other major tributaries include:

- The *Yilgarn River* which originates north-east of Southern Cross from Lake Seabrook and Lake Deborah and with tributaries to the north and south-east. It flows in a south-westerly direction past Merredin to its confluence with the Lockhart River south of Kellerberrin. The catchment area of the Yilgarn River is 55 900 km^2;
- The *Lockhart River* which originates at Lake Magenta and flows northwest through Newdegate, Kondinin, Corrigin and Bruce Rock. The catchment for this river includes the Camm River (which flows from Lake King through Hyden to Kondinin) and the Pingrup River which originates near Lake Cairlocup and flows North to Lake Grace then into the Lockhart River. The Lockhart River has a total catchment area of 32 400 km^2;
- The *South Branch* of the Avon River which flows through Brookton and joins the main channel upstream from the town of Beverley; and
- The *Mortlock River system* has a catchment area of 16 800 km^2 and joins the Avon River at Northam.

Map 1 shows the location of the Avon River and major tributaries. It also shows the location of the Aldersyde-Kweda Section of the river system.

The main channel of the Avon River downstream from the Yenyening Lakes was originally braided, with many small channels interweaving between thickly vegetated islands, and punctuated by numerous deep, shady pools. Flow in the Avon River usually commences in April after the onset of winter rains and with falling temperatures and evaporation. In most years flow diminishes or ceases before the end of December. A gauging station between Beverley and York (Broun's Farm) shows that the river flows on average for 286 days or 78% of the year while the station at Walyunga (downstream of the Darling Scarp) shows the average flow is 310 days or 85% of the year. These averages do not reflect the extreme variability between years. In a dry year, the river above Broun's Farm contributes only 12% of river flow while in a wet year this can rise to over 40%.

The Avon is now a highly disturbed river system. The riverine ecosystem has been altered due to clearing of the catchment for agriculture and establishment of towns adjacent to the river. Significantly, the riverbed was deliberately disturbed under the River Training Program undertaken from 1958-72. This involved:

- removal of channel vegetation and debris to a width of 60 metres;
- removal of dead trees, logs and debris which were considered to impair river flow;

Map 1: Location of Section 19 Within the Avon River Basin

Map 1
Location of Section 19
Within the
AVON RIVER BASIN

N

LEGEND

- Major Town/City
- Town
- Major Road
- River
- AVON — Avon River Basin Sub-Catchment

25 0 25 50 75

Kilometres

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94
Projection: MGA 94 Zone 50

Project Information

Requestee: Kate Gole
Map Author: Hamish West
Task ID: 6259
File Location: \\Pentecost\gis_projects\RS\Sn\96209\0002
Filename: map1_avon_river_basin_and_subcatchments
Date: 07/03/2006

SOURCES

DoE acknowledges the following datasets and their Custodians in the production of this map:

Dataset Name	CUSTODIAN ACRONYM	Metadata Date
Towns	DLI	08/2004
Roads, 1M, GA	GA	30/05/2002
WA Coastline 1M, GA	GA	30/06/2001
Hydrographic Catchments- Catchments	DoE	23/03/2005

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Government of Western Australia

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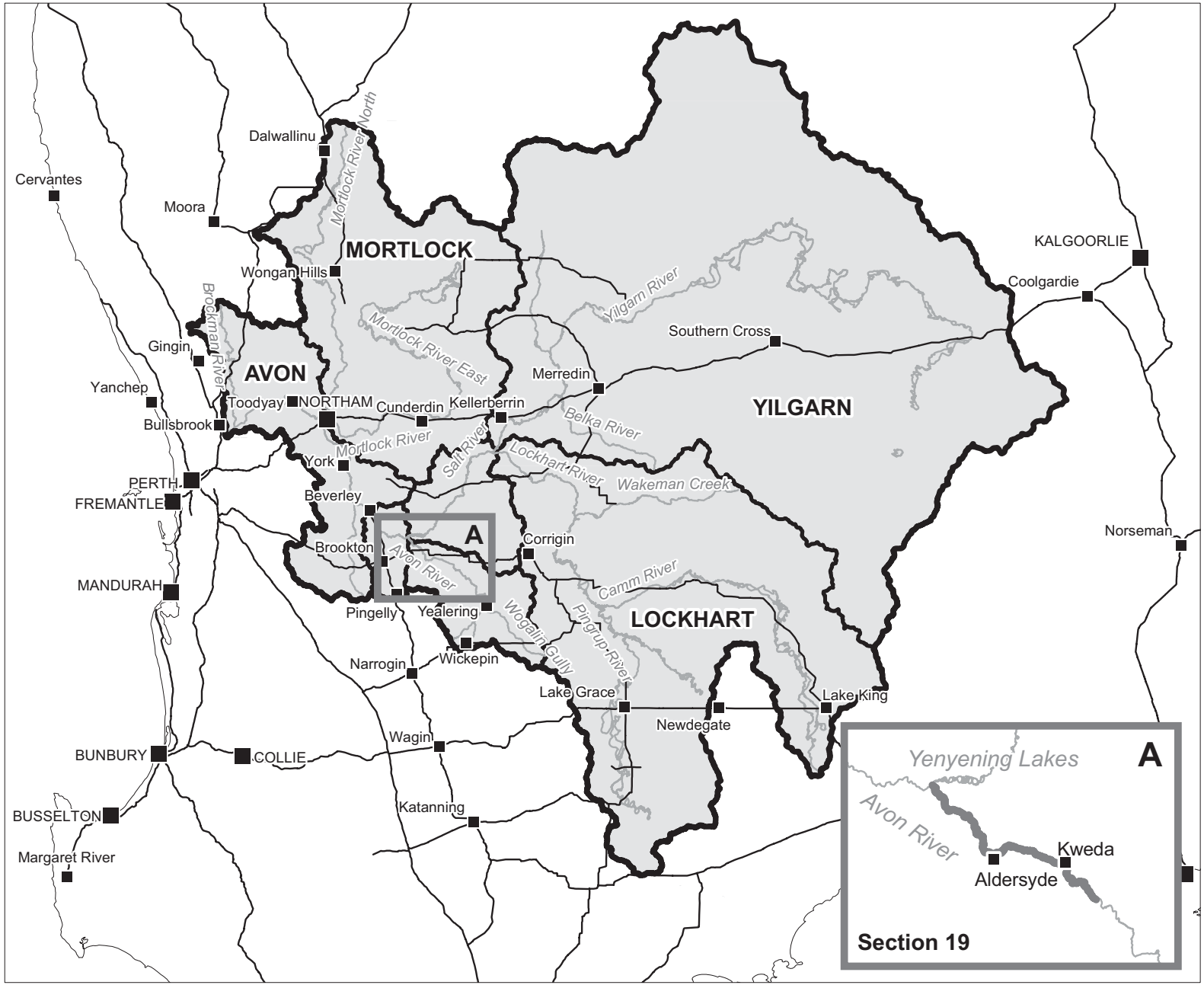


- ripping of the river bed to induce erosion of a deeper watercourse; and
- removal of minor kinks and bends in the river.

These works were undertaken for almost the entire length of the river channel from Deepdale Pool downstream from Toodyay to as far upstream as Aldersyde. The purpose of the works was to reduce flooding in towns and on farms in the floodplain. A major effect has been to double stream flow velocity that has mobilised sediments and filled river pools.

A survey of the river channel from the Yenyening Lakes down to the Avon Valley National Park – a distance of 191 km – has been completed. This shows the condition of the river and the management needs for each of the 18 River Sections. Recovery Plans have been prepared with local communities for each of these sections. A detailed description of the river, including specific assets, is provided in the respective recovery plans. Over 85% of the river is now fenced to control livestock in the riparian zone.

The key river management issues identified for the main channel of the Avon River include:

- flooding and floodplain management;
- channel erosion, bank stability and sedimentation of river pools;
- algal blooms in river pools and the Swan-Canning estuary;
- condition of riparian vegetation, including the impacts of fire, salinity and weeds; and
- public access and recreational opportunities.

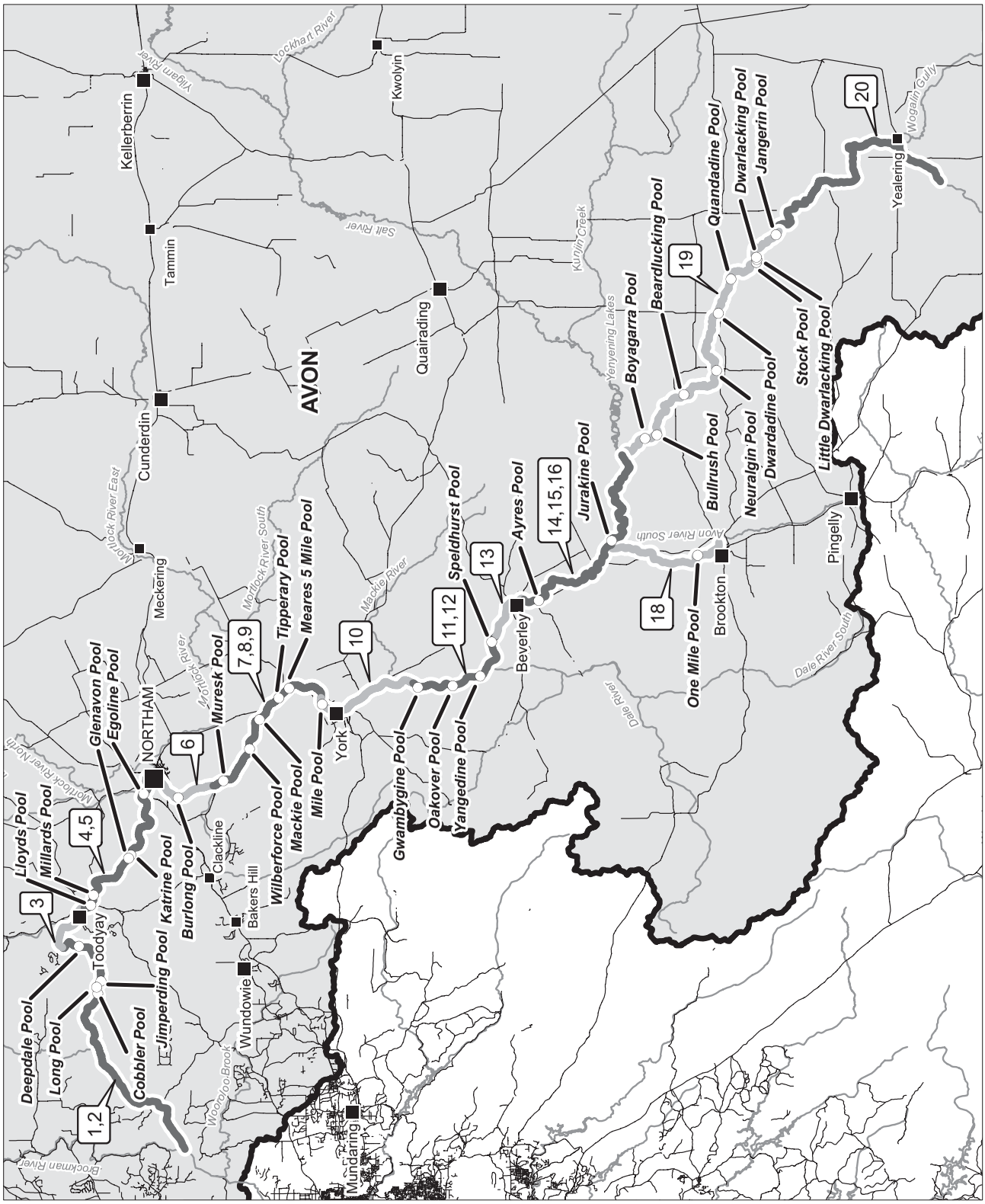
The Avon River Management Programme was prepared by the Avon River Management Authority in 1999. The functions of this authority are now replaced by the Avon Waterways Committee (AWC). The Management Programme provides strategies and priorities for river management, including river recovery planning undertaken with local communities for sections of the river.

The recovery planning process is based on a partnership approach that links landholders along the river, government agencies and the broader community to achieve common goals. Planning for the 18 sections of the main channel, including Avon River South Branch, is now complete. New initiatives are taken for the upper sections of the Avon River, including Section 19 Aldersyde-Kweda and Section 20 Yealering. The River Recovery Plan sections are shown in Map 2. The Department of Water (DoW – Northam Office) has lead government agency responsibility for river recovery planning in the Avon River Basin. DoW provides resources for the planning processes and will continue to support implementation of the recovery plan in partnership with local community organisations.

1.2 Managing Natural Resources in the Avon River Basin

The *Avon Catchment Council* (ACC) provides leadership for management of natural resources within the Avon River Basin. ACC is a non-statutory organisation based on partnership arrangements between community, governments and industry to ensure sustainable use or enhancement of water, land, vegetation and other landscape assets.

ACC has recently completed the *Avon Natural Resource Management Strategy* and the *Avon Investment Plan*. The strategy provides direction and priorities for actions required for targeted resource condition change. The Investment Plan identifies the resources required to



Map 2: Avon River River Pools and Recovery Sections

implement the actions. The strategy and plan are accredited for Commonwealth and State funding under the National Action Plan for Salinity and Water Quality (NAP) and the continuation of the Natural Heritage Trust (NHT2).

The ACC has initiated regional-scale projects in accordance with the priorities of the regional strategy and investment plan. Management of water resources, including river and lake systems, is a high priority.

1.3 The Need for a Recovery Plan

The Aldersyde-Kweda section of the Avon River is a well defined river ecosystem with significant river pools valued by those who live along the river. The river is now degraded in many ways, including the impacts of salinity and sedimentation.

The Recovery Plan is focused on identifying opportunities for improvement of the river ecosystem rather than building expectations of full river recovery. The survey and planning processes are required to develop an understanding of river management and align this with community interests and priorities for managing local landscapes.

A considerable body of information has been developed during preparation of a management plan for Boyagarra Pool (UWA Centre for Water Research, 1999). This information is also relevant to management of this section of the river.

A foreshore and channel condition survey for this section of the river was undertaken during September, 2005. The Aldersyde-Kweda Section Recovery Plan provides a management framework for the specific management actions developed from the river survey.

The Recovery Plan identifies actions to be undertaken within the riverine environment. It does not extend to the full catchment for each of the tributaries to this section of the Avon River. In this way, the Recovery Plan is consistent with other recovery planning processes downstream but differs to the Yealering Lakes Section Recovery Plan. Management of water resource assets, particularly lakes, upstream from Squires Road (Shire of Corrigin) is integrated with other catchment management requirements for this upstream river section.

1.4 The River Survey

The survey of the Aldersyde-Kweda Section of the Avon River was undertaken during the period 22 September to 1 October 2005. The survey commenced at the Yenyening Lakes and was undertaken on the left-hand side (LHS – as viewed looking up-stream).

Survey information was recorded for each 500 metre interval by walking the interval length and recording observations and measurements at the end-point. A Global Position System (GPS) reading was recorded for each end-point (Pt 0-1 to Pt 118-119).

There are 119 recorded information sets for the survey. While the survey was undertaken on the LHS (with the exception of Pt 117-119), observations were made of the RHS river environment. The recorded survey information is more detailed for the LHS (eg for the occurrence of weeds) however the combined information for both sides of the river provides a good indication of the river condition and management requirements.

The information recorded for each 500 metre interval was:

- **River Channel Condition** (channel width and formation, braiding, bank erosion, channel scour, sediment deposition, island formation and

stability, anabranches and diversions, partial levees formed by the River Training Scheme, channel debris);

- **Riparian-Zone Vegetation** condition (dominant tree and shrub species occurrence, senescence and regeneration, level of cover, habitat values, aquatic plants, adjacent remnant vegetation, areas of distinctive high biodiversity value, salinity impacts);
- **River Pools and Billabongs** (length, depth, sediment load, conservation values, public access opportunities);
- **Water Quality** (Electrical conductivity –for salinity, pH and temperature for each end-point. Note that pH information for Pt 1-52 only is available);
- **Tributaries** (condition, sediment load, weeds, water quality);
- **River Fencing Condition** (categorised as 'good', 'moderate' or 'poor'. An estimate of the remaining life length for 'moderate' fencing was made);
- **Fauna** (bird species richness, other fauna observations);
- **Weeds and Unwanted Animals** (important weeds for management, foxes and rabbits);
- **Foreshore Condition** (assessed according to 4 grades (A, B, C, D) according to Pen and Scott, 1995);
- **River Heath Index** (assessment based on cumulative scores for riparian vegetation condition, stream cover channel bank stability, sediment load, habitat diversity and adjacent land use); and
- **Management Issues** (existing management, fire risk, salinity, drains, stock access, public road or farm crossings, recreation or public access opportunities and rubbish).

The information was recorded on a field proforma for each 500 metre interval.

1.5 Linking the River Survey and Recovery Plan

The Aldersyde-Kweda Section of the Avon River is represented in 24 Photo Sections based on aerial photographs (Appendix One). The 119 survey intervals are identified on the Photo Sections each with 4-5 survey intervals. Appendix Two shows the air photo and assessment notes for Photo Section One (Pt 0-4) as an example.

The recorded information and assessment for each Photo Section provides an opportunity for small groups of neighbouring landholders to undertake co-ordinated action for sections of river most relevant to them. The landholders involved in each Photo Section are identified however the suggested management actions are not attributed specifically to individual landholders with the expectation that there will be co-operative effort for the actions required in each Photo Section. The current landholders adjacent to the river are listed in Appendix Three.

The detailed actions for each Photo Section are not included in the Recovery Plan but are instead provided directly to the land holders involved. New landholders are encouraged to contact the Department of Water Northam Office on (08) 9622 7055 for a copy of the information for their Photo Section. The Recovery Plan provides the frame-work for coordination of these actions by identifying priorities and targets for the complete Aldersyde-Kweda Section of the Avon River.

2 Description of the Aldersyde-Kweda Section

2.1 Location

The Aldersyde-Kweda section of the Avon River extends upstream from the confluence of the river with Yenyening Lakes at Qualandary Crossing to Squires Road crossing. The river channel and floodplain in this section are well defined and has land tenure separate from adjacent freehold farmland. The river is less well defined and occurs on private land upstream from Squires Road.

This section of the river is approximately 25 km east of the Town of Brookton and 175 km south-east from Perth. Map 3 shows the location of the river section.

The Aldersyde-Kweda section is located within the Shires of Brookton, Corrigin and Pingelly.

Table 1 provides a list of the major river features for each of the 24 Photo Sections.

Table 1: River features for each of the Aldersyde-Kweda Photo Sections

Photo section	River features and infrastructure assets
1	• Yenyening Lakes • Qualandary Road Crossing
2	• Minor tributaries
3	• Boyagarra Pool • Boyagarra Road • Tributary confluence
4	• Bullrush Pool
5	• Nalyaring Gully confluence
6	• Jaensch Road crossing
7	• Brookton-Corrigin Road crossing
8	• Beadlucking Pool • Minor tributary confluence • Falls Road crossing
9	• Minor meanders with anabranches
10	• Tributary confluence (with localised flooding and sedimentation)
11	• Neuralgin Pool • Upstream limit of River Training Scheme • Aldersyde Road crossing
12	• Sandplain Creek confluence (including Petercarring Brook) • Localise flood risk on the northern floodplain
13	• High salt and flood risk on northern floodplain
14	• Broad valley floor with high salt and flood risk
15	• Watts Lake (fresh) tributary confluence • Localised flooding on southern floodplain
16	• Significant anabranch departing downstream of the Dangin-Mears Road crossing • Dwardadine Pool • Dangin-Mears Road crossing • Tributary from north (diverted by agricultural drainage) confluence
17	• Significant anabranch • High floodplain salt risk
18	• Brookton-Kweda Road crossing
19	• Quandadine Pool
20	• Extensive riparian vegetation • Tributary confluence • Kweda golf club adjacent to the river • Kweda Road crossing
21	• Major river meanders
22	• Little Dwarlaking Pool • Dwarlaking Pool within a reserve • Significant oxbow formation south of pool in reserve • Salt and flood risk in southern floodplain • Wilson Road crossing
23	• Tributary confluence • Salt and local flooding risk east and west of the river
24	• Dwarlaking Creek confluence • Woyerling Creek (north) confluence • Significant meander • Salt and local flooding risk south and east of the river • Jangerin Pool with adjacent reserve

2.2 Catchment and Landscape

The catchment area for the Upper Avon River (upstream from Boyagarra Pool) is over 3100 km^2 (2.6% of the Avon River Basin). This includes the catchment area in the Yealering Lakes Section Recovery Plan.

The Yealering Lakes sub-region is one of nine Land Resource sub-regions within the Avon River Basin (DAWA, 2003). It occurs on granites and gneisses in the central 'Wheatbelt' and the Great Southern district.

The sub-region is characterised by low relief landscapes. Grey lateritic gravelly sandplain is found on uplands originally vegetated by diverse heath, and sandy duplex soils are found in flat valleys (2-3 km wide), originally vegetated by salmon gum and wandoo woodland. The majority of lakes within the sub-region were fresh prior to clearing.

The annual rainfall for the locality is 400 mm, with 80% occurring during the May-October growing period. There is high rainfall variability years and relatively high spatial variation. Annual evaporation is approximately 1900 mm.

The landscape formerly had exceptionally rich biota and high species endemism (ie occurring only within this region) particularly for wildflowers. The Avon Wheatbelt IBRA region (Thackway and Cresswell, 1995), which includes the Aldersyde-Kweda Section, is also one of 15 biodiversity 'hotspots' that have been identified as nationally important.

Clearing for agriculture commenced after early settlement during the 1840s and expanded significantly after completion of the Great Southern railway in 1889. Access to the river as part of a land grant was considered a major asset for both domestic and stock water use. The river was then broad and sluggish with braided channels (many inter-weaving waterways) and river pools. Some pools were relatively fresh, especially if fed by groundwater seepage. Others were brackish and occasionally mal-odorous due to decaying plant material and animal carcases (Clack, 1999).

The landscape is now dominated by agricultural land use and people not living near the river have little knowledge about this local asset (UWA Centre for Water Research, 1999).

The extent of salinity within the Yealering Lakes sub-region is currently 5.6% of agricultural land (the extent for the Avon River Basin is 4.5%). It is estimated that this could increase to 19.1% (over 25% for the Avon River Basin) based on information derived from the Land Monitor Project (a project undertaken by State Government agencies in 2002 that linked digital elevation modelling to aerial photography and satellite imagery with calibration for local landform).

Sub-surface soil compaction is a significant land management issue identified for the Yealering Lakes sub-region (DAWA, 2003).

2.3 Stream Flow, Channel and Floodplain

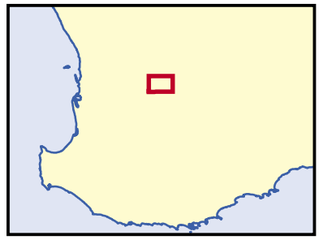
Stream flow

Stream flow from the Upper Avon contributes approximately 20% of total stream flow at the Broun's Farm gauging station (which is located downstream of the confluence with the Dale River). Flow at this gauging station occurs on average 286 days each year. The number of flow days for the Upper Avon is not known but would be considerably less than at Broun's Farm.

Model estimates suggest that a 1-in-2 year flood event at Boyagarra Pool would have a flow rate of 55 m^3/sec. A 10 year flood event would flow at approximately 180 m^3/sec and a 50 year flood at 600 m^3/sec.

Map 3
ALDERSYDE-KWEDA Section

LOCALITY MAP



LEGEND

- Pool
- Town
- Local Road - Sealed
- Local Road - Other
- Section 19
- Subcatchment
- Watercourse
- Local Government Authorities
- Crown Reserve
- Catchment

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94
Projection: MGA 94 Zone 50

Project Information

Requestee: Kate Gole
Map Author: Hamish West
Task ID: 6259
File Location: \\Pentecost\gis_projects\RS\Sn\96209\0002\
File Name: map3_aldersyde_kweda_section_management_area
Date: 16/03/2006

SOURCES

DoE acknowledges the following datasets and their Custodians in the production of this map:

Dataset Name - CUSTODIAN ACRONYM - Metadata Date		
Hydrographic Catchments - Catchments	DoE	23/03/2005
Hydrographic Catchments - Subcatchments	DoE	23/03/2005
Hydrography, linear(hierarchy)	DoE	13/04/2004
Road Centreline, DLI	DLI	01/04/2004
Cadastre	DLI	01/12/2005
Local Government Authorities	DLI	08/07/2004
CALM Managed Lands and Waters	CALM	01/07/2005
Localities, AUSLIG	AUSLIG	01/01/1997

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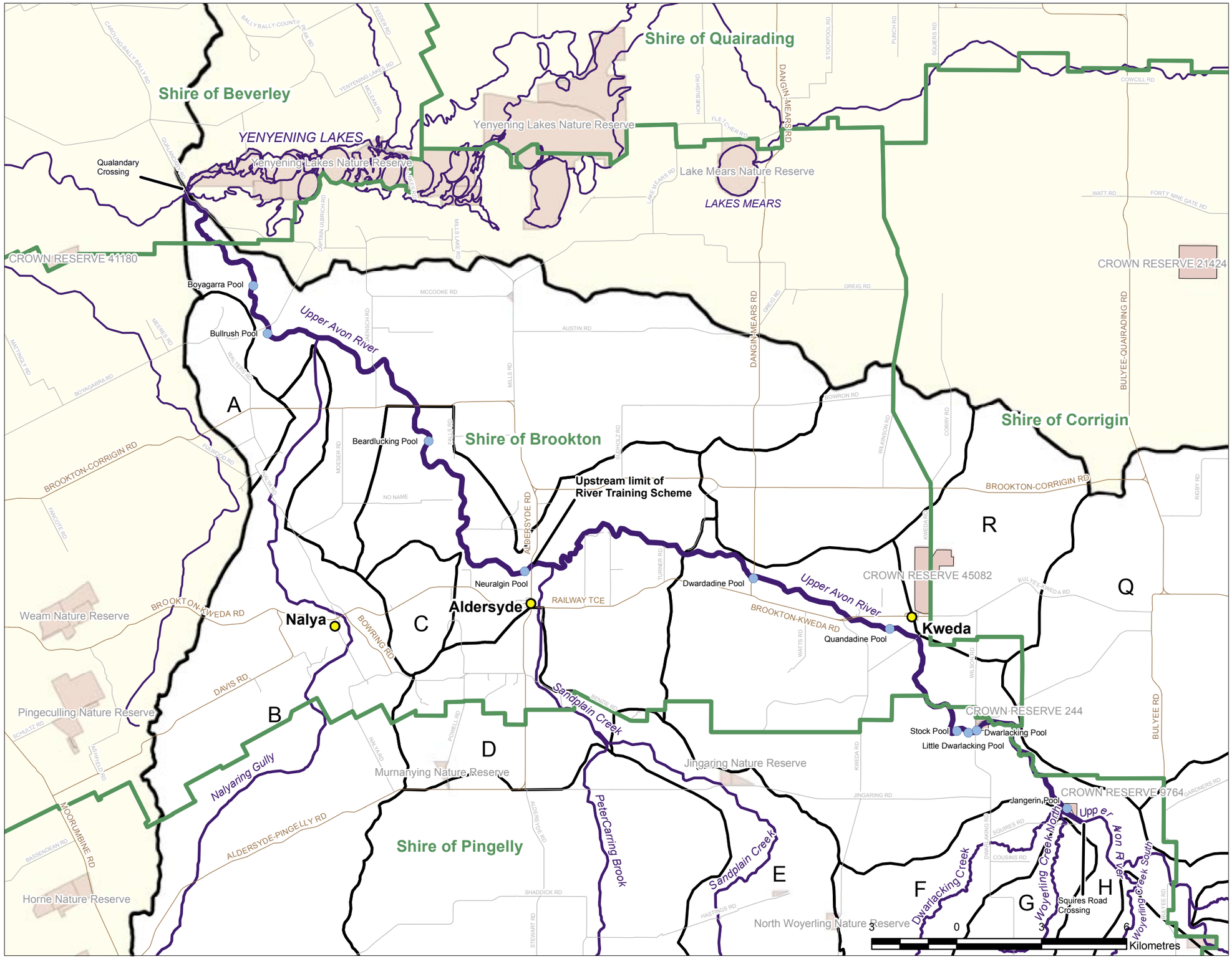

Map 3: Aldersyde-Kweda Section

A 1-in-20 year flood event would have a depth of approximately 3.5 m in Boyagarra Pool (UWA Centre for water Research, 1999).

Channel condition

The river channel extends 60 km from the Yenyening Lakes to Squires Road. The river is generally orientated to flow north-west. The river elevation is 250 m AHD near Squires Road and 210 m AHD near Qualandary Crossing. The average gradient for this section is 1 m in 1.12 km (0.09%). It has a broad geologically controlled meander pattern and a finer meander pattern determined by fluvial (river flow) processes. There are many alternative floodways (anabranches) from the former braided river channel. These are functional in high flow events and occasionally become the main channel.

There is a single river channel for almost all of the river section although it is mildly braided in Photo Sections 12, 13 and 16. The broad alluvial river bed ('samphire flats') in Photo Sections 23 and 24 (Pt 113-118) has many alternative flood ways although the current stream flow channel is well defined (Photo 1). Tributary flow across these flats is in separate channels to the river.

The channel bank is actively scouring in some sections (Photo 2) although the bank is generally stabilised by samphire (*Halosarcia* spp.) on both sides for all of the river section, including sections altered by the River Training Scheme (RTS). The locations with greatest channel bank erosion occur where deep unconsolidated sandy-textured soils ('sand lenses') are intersected by the river (Photo 3). The areas at risk are identified for each Photo Section. Further bank erosion is occurring where stream flow has recently diverted to an alternative channel (eg Photo section 20, Pt 91-94) (Photo 4).

The river channel width ranges from being less than 5 metres to over 20 metres. Works undertaken as a part of the RTS before 1973 altered the channel characteristics. The extent of works were from Qualandary Crossing to Aldersyde. These works caused massive mobilisation of sediments as the channel has scoured to a depth of 1-2 m and a width of about 30 m leading to infill of river pools and sediment aggregation within the altered river channel (Photo 5) . The sediment mobilisation processes within the lower reaches of this river section have been surveyed and analysed for management of Boyagarra Pool (UWA Centre for Water Research, 1999). This analysis shows that there is substantial aggregation of sediments in some locations forming lateral bars which lower channel gradient and slow stream flow. These aggregating processes are slowly forming a braided stream channel as existed before the RTS. Some parts of the channel are now deficient of sediment due to scouring processes so are unable to rehabilitate by sediment aggradation. This occurs downstream from Boyagarra Pool.

Where the RTS has not altered the river (ie upstream from Aldersyde), the channel is narrow where it is braided or stable, and wide where there are pools or the river channel is eroding. Continuing channel erosion is thought to occur due to increased stream flow resulting from the RTS downstream (ie reduced impedance to flow in the lower reaches). It is likely that the erosion processes in these upper sections of the river are now a greater source of bed load sediments than that from the channel downstream of Aldersyde.

Sediments continue to be re-positioned within the river channel. Significant areas of deposition are identified as 'sand slugs' for each Photo Section (eg PS 9, Pt 38-39, PS 18, Pt 85-86) (Photo 6). It is difficult

Photo 1: Samphire flats at Pt 115 in Photo Section 24

Photo 4: Unconsolidated sediments on banks in Photo Section 10

Photo 2: Active channel erosion in Photo Section 14

Photo 5: River bed scour resulting from River Training Scheme

Photo 3: Erosion of 'sand lens' intersected by the river in Photo Section 11

Photo 6: 'Sand slug' in Photo Section 6

Map 4 ALDERSYDE-KWEDA Floodplain and salt affected areas

LEGEND

- Local Road - Sealed
- Towns
- Local Government Authorities
- Areas at Risk of Becoming Saline
- Recent Saline Areas (1995-1998)
- Older Saline Areas (1989-1991)
- Year 2000 Bush Mask
- Landsat TM Band 5 Background

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94

Project Information

Requestee: Kate Gole
Map Author: Hamish West
Task ID: 6259
File Location: \\Pentecost\gis_projects\RS\Sn\96209\0002\
File Name: map4_salt_affected_areas
Date: 17/03/2006

SOURCES

DoE acknowledges the following datasets and their Custodians in the production of this map:

Dataset Name - CUSTODIAN	ACRONYM	Metadata Date
Road Centreline, DLI	DLI	01/04/2004
Town Site Boundaries	DLI	27/09/2002
Local Government Authorities	DLI	08/07/2004
Salinity Mapping LM 25m	DLI	11/2001

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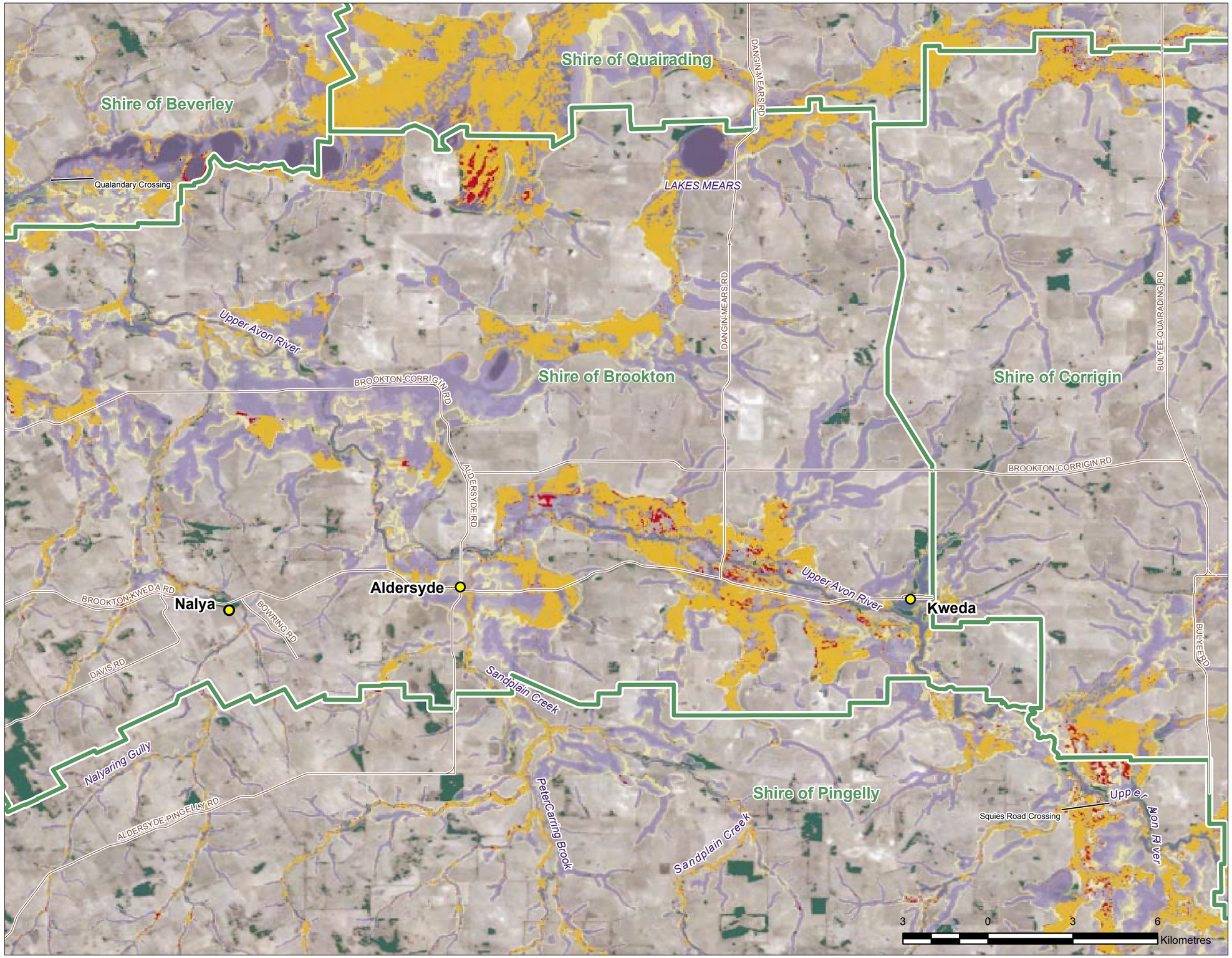
This map was produced with the intent that it be used for Avon River Recovery Plans at the scale of 1:135,000.

While the Department of Water has made all reasonable efforts to ensure the accuracy of this data, the Department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.



Map 4: Aldersyde-Kweda Floodplain and Salt Affected Areas

to identify which 'sand slugs' are unstable and are a risk downstream however many seem to be stabilising as vegetated islands. Unlike the bed of the Avon River downstream of Qualandary Crossing, salt water couch (*Paspalum vaginatum*) has only very limited distribution (eg Photo Section 2, Pt 9-10) and is not a major stabilising agent.

Anabranches (former significant river channels) and smaller alternative flood ways are common in this section of the river. The distinctive 'ox-bow' pattern is clearly identified at Dwarlacking Pool (Photo Section 22, Pt 104-106). These are important for distributing flood flows and generally should not be altered. The RTS works resulted in partial levee banks on one or both sides of the river which in some parts deny flood access to these flood-ways.

There are five locations where the present stream flow of the river is either in an alternative flood way or has divided stream flow. They are:

- Photo Section 3 (Pt 11-12) – immediately upstream of Boyagarra Pool;
- Photo Section 10 (Pt 45-46);
- Photo Sections 15 and 16 (Pt 70-77) – diversion downstream from the Dangin-Mears Road Bridge;
- Photo Section 17 (Pt 78-81); and
- Photo Section 20 (Pt 91-94) – upstream from the Kweda Road bridge.

These are important as the recent flow diversion in each situation is causing significant channel erosion and is a source of additional bed-load sediment.

The amount of woody debris in the river channel varies significantly. There is very little in the channel downstream from Aldersyde (due to the RTS) but upstream the content of woody debris in the river varies from none to a high level of logs and branches (Photo 7). Where it occurs, debris in the river adds to habitat value and is not considered to be a significant cause of flow constriction resulting in flooding.

Floodplain

The floodplain is relatively well defined within a broad valley floor that is about two kilometres wide. Map 4 shows the extent of the floodplain and the extent of existing salt affected land based on information derived from the 'Land Monitor' project.

A distinctive feature of the floodplain is lenses of unconsolidated coarse sand (identified as 'sand lenses'). These have perched groundwater aquifers that were previously significant for farm water supply but are now generally salt-affected. Where they are adjacent to the river, fresh seepage commonly occurs which is important to the health of the river ecosystem (eg PS4, Pt 17-18).

The 'sand lenses' are very extensive in the flood plain of the Aldersyde-Kweda Section. Their extent has been mapped from aerial photos for each Photo Section and is detailed in Table 2.

Some of these areas have been established with commercial maritime pine (*Pinus pinaster*), other areas may be suitable for establishing commercial sandalwood (*Santalum spicatum*) plantations. Areas of 'sand lens' adjacent to the river that have not been cleared generally have quite high conservation value.

Most of the floodplain is currently used for agriculture although considerable areas are now salt-affected (Map 4). The area most affected by salinity is shown in Photo Sections 12-17 and 23-24 (Appendix 2). The extent of salinity is expected to increase significantly within the floodplain. A description of the processes of salinity relevant to the river floodplain is provided

Photo 7: Woody debris in the river channel at Pt 84 in Photo Section 18

Photo 10: Calistemon phoeniceus *on LHS in Photo Section 6*

Photo 8: Salmon Gum verge on RHS in Photo Section 2

Photo 11: Senescent Banksia prionotes *on LHS in Photo Section 6*

Photo 9: Regeneration of Acacia microbotrya *in Photo Section 3*

Photo 12: Single healthy Banksia prionotes *in Photo Section 6*

in the *Yenyening Lakes Management Strategy 2002-2012* (Water and Rivers Commission, 2002).

Table 2: Sand lense locations

Photo section	Survey section
PS4	Pt 16-17
PS6	Pt 25-26
PS7	Pt 28-30
PS8	Pt 33-38
PS9	Pt 38-39
PS10	Pt 45-46
PS11	Pt 49-52
PS13	Pt 59-60
PS14	Pt 67-68
PS15	Pt 69-73
PS17	Pt 78-81
PS18	Pt 82-87
PS19	Pt 87-91
PS20	Pt 91-94
PS21	Pt 98-100
PS22	Pt 104-107
PS23	Pt 110-113
PS24	Pt 113-115, RHS
PS24	Pt 116-118, LHS

There is concern about saline floodwaters inundating the floodplain and increasing the area of salt-affected land. This has been identified by landholders particularly for areas upstream of the RHS tributary confluence in Photo Section 10 and the LHS tributary confluence in Photo Section 12.

2.4 Riparian-zone vegetation

The dominant tree and shrub species are recorded for both sides of the river in the Photo Section notes. The most commonly occurring trees are flooded gum (*Eucalyptus rudis*), York gum (*Eucalyptus loxophleba*), salmon gum (*Eucalyptus salmonophloia*), wandoo (*Eucalyptus wandoo*) and swamp sheoak (*Casuarina obesa*). The most commonly occurring tall shrubs are paperbarks (*Melaleuca raphiophylla*), needle bush (*Hakea preissii*), variable-leaved hakea (*Hakea varia*), jam (*Acacia acuminata*), manna gum (*Acacia microbotrya*), spiked scholtzia (*Scholtzia involucrate*) and lesser bottlebrush (*Calistemon phoeniceus*).

Most of the riparian zone for the Aldersyde-Kweda Section has dominant vegetation that is senescent and in some places, most is now dead. Increasing salinity is the major cause of decline. The areas most affected are in Photo Sections 12-17.

Flooded gum (*Eucalyptus rudis*) and paperbark (*Melaleuca raphiophylla*) were originally commonly occurring but are now in significant decline regenerating only where there is fresh seepage (eg PS2, Pt 9-10 and PS22, Pt 104-105). Salmon gum (*Eucalyptus salmonophloia*) occur generally in thin remnant verge strips (Photo 8). This species is recorded in the survey notes to be regenerating only at PS12 (Pt 52-53). The most commonly regenerating tree is swamp sheoak (*Casuarina obesa*). This species is more tolerant of increasing salinity than most other trees and shrubs in the river environment. *Acacia microbotrya* is regenerating in small groves (Photo 9) as is *Calistemon phoeniceus* (Photo 10). *Banksia prionotes* is senescent or dead in all locations where it occurs with few exceptions, for example on healthy plant at PS6 Pt 23-24 (Photos 11 and 12). This may be due to the spread of a root fungus (*Phytophthora cinnamomi*) or perhaps due to excess nutrients in the soil profile.

There is a range of sedges and rushes that occur in the river environment. These are considered to have been previously more common. There are some locations

where beds of sedges/rushes remain, mostly associated with pools or a tributary confluence (eg PS2, Pt 7-8 and PS 10, Pt 46-47).

The level of vegetative cover for the river is generally quite poor. (Photos 13 and 14 shows the unusual situation of good stream cover). There are very few sections where there is shading of river pools at a level that will reduce the summer temperature of water bodies. The level of cover is recorded for the Photo Sections and is a component of the River Health Index (section 2.12).

There are very few aquatic plants in the river with the significant exception of a commonly occurring species, probably a *Ruppia* sp. upstream from PS12, Pt 57. This is thought to have been introduced to the river system although occurs naturally in Western Australia. The occurrence of *Ruppia* is recorded for each Photo Section. A general observation is that a high level of this aquatic plant correlates with a relatively low level of the conspicuous filamentous algae indicating that *Ruppia* significantly reduces the nutrient load of stream flow. A second aquatic plant was recorded in a relatively fresh billabong (PS8, Pt 34-35, LHS).

Some sections of the river have very narrow riparian vegetation width while for other areas it is quite wide and adjoins private remnant vegetation or reserves. The value of linkage to other vegetation is a component of the River Health Index (section 2.12).

There are locations where the combination of the river environment and adjacent natural vegetation has high biodiversity or other conservation value (Photo 15). These are identified in the Photo Section notes. The most common occurrence is where a vegetated 'sand lens' is adjacent to the river. Otherwise there are reserves that add significant conservation value (eg at Dwarlacking Pool in PS22 and Jangerin Pool in PS24). The key locations with high biodiversity value are detailed in Table 3.

The location at PS19 (Pt 89-91) near Kweda is of particularly high potential conservation value because of extensive 'sand lens' vegetation on one side of elongated pools and natural vegetation in Crown Reserves on the other side.

Table 3: High biodiversity value locations

Photo section	Survey section
PS6	Pt 23-24 LHS
PS8	Pt 36-37
PS9	Pt 40-42
PS11	Pt 50-52
PS12	Pt 53-55 RHS
PS14	Pt 65-66
PS14	Pt 67-68 RHS
PS17	Pt 78-79 LHS
PS18	Pt 84-85 LHS
PS19	Pt 89-91
PS20	Pt 91-93
PS22	Pt 103-105
PS24	Pt 116-119

2.5 River Pools and Wetlands

River pools are a significant characteristic of the Avon River. Until relatively recently, many of the larger pools in the Aldersyde-Kweda section were used for swimming and some were used for water supply or for the past practice of sheep-washing (eg at Stock Pool, PS22). Many pools were well known for the now illegal sport of duck-shooting. Dwarlacking Pool (PS22) was used through summer for family or community picnics. Remnants of a diving board and tennis courts indicate the previous social value of this pool (Photos 16 and 17).

Photo 13: Good stream cover at Bullrush Pool in Photo Section 4

Photo 14: Good stream cover at Bullrush Pool in Photo Section 4

Photo 15: Sand lens vegetation with minimal weeds on LHS in Photo Section 7

Photo 16: Upstream end of Dwarlacking Pool at Pt 105 in Photo Section 22

Photo 17: Diving board structure at Dwarlacking Pool in Photo Section 22

Photo 18: Fresh billabong with Typha *on LHS in Photo Section 8*

The river pools also provide significant summer and drought refuge for water-birds. Most pools originally had relatively dense fringing vegetation dominated by flooded gum (*Eucalyptus rudis*) and paperbarks (several species of Melaleuca) and a verge of sedges and rushes. While some have remnants of this vegetation community, most is in decline due largely to increased salinity.

There are 10 major pools that are locally well known. These pools, shown on Map 3, are:

- Boyagarra Pool – PS3 (Pt 10-11)*
- Bullrush Pool – PS4 (Pt 15-16)
- Beardlucking Pool – PS8 (Pt 33-34)
- Neuralgin Pool – PS10 (Pt 47-48)
- Dwardadine Pool – PS16 (Pt 76-77)*
- Quandadine Pool – PS19 (Pt 88-91)*
- Stock Pool – PS22 (Pt 102-103)*
- Little Dwarlacking Pool – PS22 (Pt 103-104)*
- Dwarlacking Pool – PS22 (Pt 104-105)
- Jangerin Pool – PS24 (Pt118-119)*

The major pools identified with an asterisk (*) are considered to be a priority for on-going management. The others are considered to be now substantially filled with sediment and may not be feasible to recover.

During the river survey, 25 additional pools that are less well known locally were identified. They are identified for each Photo Section and are tabled below.

Most of these pools are relatively shallow and may not persist long through summer months. Some were probably deep (> 2 metres) but are now filled with sediment. The three pools marked with an asterisk (*) are considered to be of high value and a priority for management.

Only three of these smaller remnant pools are located downstream of Aldersyde while 22 are located upstream. It is clear that many smaller pools were lost as a result of the River Training Scheme.

Table 4: Additional river pools identified during the river survey

Photo section	Survey section
PS6	Pt 24-25
PS8	Pt 35-36*
PS10	Pt 47-48
PS12	Pt 58-59
PS13	Pt 60-61
PS13	Pt 62-63
PS13	Pt 64-65
PS14	Pt 67-68
PS15	Pt 69-70
PS15	Pt 71-72
PS16	Pt 75-76
PS17	Pt 77-78*
PS17	Pt 81-82
PS18	Pt 82-83
PS18	Pt 84-85
PS21	Pt 96-97
PS21	Pt 97-98
PS21	Pt 100-102*
PS22	Pt 105-107, 3 pools
PS23	Pt 108-109
PS 23	Pt 109-110
PS24	Pt 113-114
PS24	Pt 114-115

The distance between pools within a river is often an effective measure of the energy distribution of the river. The average distance between the major pools is approximately 6 km although some are half that distance and others are double the distance (UWA Centre for Water Research, 1999). This analysis however does not account for the large number of smaller pools that previously occurred in the Aldersyde-Kweda Section of the Avon River. Prior to the RTS, there may have been over 50 river pools with an

average spacing distance of a little over 1 km. Even this smaller pool spacing is considerably greater than the theoretical distance for energy dissipation, which is 5-7 magnitudes of channel width (ie up to 250 metres).

Sediment sampling within Boyagarra Pool suggests that sediment mobilisation occurs primarily during flood events. Computer modelling suggests that scouring of sediments from river pools will require a flood flow in excess of 1 400 m^3/sec. Other modelling shows that a major flood flow (1-in-50 year occurrence) would be approximately 600 m^3/sec. (UWA Centre for Water Research, 1999) so it is unlikely that the pools will be maintained or reformed through natural river rehabilitation processes.

Boyagarra Pool is the first pool upstream from Qualandary Crossing. The pool is approximately 600 m long, 14 m wide and had a maximum depth of 3 m prior to infilling. The total volume of the pool was approximately 21 000 m^3, much of it was filled with sediments. The pool has a high level of nutrients in the sediments and water body, however the pool is biologically productive through macrophyte growth which utilises some of the nutrients.

There is considerable information about this pool compiled during extensive academic studies by the University of Western Australia (Centre for Water Research) in 1999 under contract arrangements to the Water and Rivers Commission (now Department of Water). The studies were collated for preparation of the Management Plan for the Rehabilitation of Boyagarra Pool (UWA Centre for Water Research, 1999). The sectional components of the study are:

- *Catchment Report* – landscape-scale information about climate geology, hydrogeology, soils, vegetation, land use, erosion, nutrient pathways, salinity and waterlogging;
- *History and Sociology Report* – Aboriginal and European settlement history, and results of a local field survey;
- *Hydrology Report* – information and analysis of rainfall, stream-flow and flooding;
- *Sediment Report* – concepts of sediment transport, ediment distribution and pool sediment analysis;
- *Modelling Report* – water, salt, nutrient and sediment balance modelling;
- *Biology Report* – survey information for macrophytes, phytoplankton and micro-organisms within the pool, terrestrial fauna, proposals for habitat management;
- *Water Quality Report* – physical and chemical properties measures (and compared with environmental standards), comparison with Gwambygine Pool (near York); and
- *Engineering Solutions Report* – evaluation of sediment removal, use of riffles and riprap or gabions, woody debris, revegetation and details for design and implementation.

A restoration program was implemented following the release of the management plan in 1999. In 2001 and 2002, approximately 6000 m^3 of coarse sediments were removed from the pool by dredging. From 2000 to 2002 several areas surrounding the pool were revegetated with local native species. Rushes and sedges were also planted to create habitat for native fish, frogs and reptiles.

Plantings in mid-winter included species such as jam (*Acacia acuminata*), manna gum (*Acacia microbotrya*), York gum (*Eucalyptus loxophleba*), swamp saltbush (*Atriplex amnicol*a) and creeping saltbush

Photo 19: Boyagarra Pool prior to dredging, April 2002 (Department of Water)

Photo 20: Boyagarra Pool following the removal of 6000 m^3 of sediment, August 2002 (Department of Water)

(*Atriplex semibaccata*). Plantings in late winter to early spring included shore rush (*Juncus kraussii*), flooded gum (*Eucalyptus rudis*), salt river gum (*Eucalyptus sargentii*) and mohan (*Melaleuca viminea*). During the summer of 2000-2001 unfenced areas of the pool were fenced to exclude stock under the Avon Fencing Program. There have been on-going surveys to monitor further influx of sediment. The last survey was carried out in 2004 and showed that there has been little further sedimentation of the pool due to a re-forming of the original braided structure of the upstream channel.

The source of sediments in the pool is from the eroding river channel and from major tributaries. Nalyaring Gully is noted as having a high sediment load (UWA Centre for Water Research, 1999) however other tributaries also contribute to the river sediment load. It is also noted that the sediment load is depleted downstream of the Boyagarra Pool and this may limit the opportunity for channel rehabilitation.

In addition to the river pools, there are several wetlands ('billabongs') in flood ways adjacent to the river (Photo 18). Some are formed by seepage from 'sand lenses' and others by the confluence of a tributary. The most significant wetlands are located at PS5 (Pt 19-20), PS7 (Pt 31-32), PS8 (Pt 34-35), PS9 (Pt 41) and PS10 (Pt 45-46). All are located on the LHS probably due to the walking survey being on that side of the river. There may be others on the RHS not recorded during the survey.

2.6 Water Quality

Salinity of stream flow is a key threat to the ecology of the river ecosystem. Results from the survey (undertaken 22.09.2005-01.10.2005) show that the electrical conductivity (EC), a measure of total soluble salt concentration, increases upstream (Figure 1). Near Qualandary Crossing, the EC was 21.6 mS/cm (11 880 mg/L). This increased steadily to 26.9 mS/cm (14 795 mg/L) at Aldersyde (Pt 52). The increase in EC readings at this point is probably not significant as it coincides with a change in survey period (ie a week later) and may reflect change in instrumentation.

Table 5 details a salinity classification, with typical values for seawater as a comparison, for different salinity units.

The EC readings do not change significantly from Pt 54 to Pt 103. It is within this part of the Aldersyde-Kweda Section that the flood plain and river environment are most salt-affected. There is a distinct 'spike' in EC at Pt 107

Table 5: Salinity classification

Classification	mg/L	mS/m	mS/cm	grains/gallon
Fresh	0 – 550	0 – 100	0 – 1	0 – 38
Marginal	550 – 1100	100 – 200	1 – 2	38 – 77
Brackish	1100 – 5000	200 – 900	2 – 9	77– 346
Low saline	5000 – 11000	900 – 2000	9 – 20	346 – 770
High saline	11000 – 30000	2000 – 4500	20 – 45	770 – 1733
Hyper-saline	30000 – 88000	4500 – 12200	45 – 122	1733 – 4697
Sea water	**35 000**	**6363**	**64**	**2450**

increasing to 36.5 mS/cm (20 075 mg/L). This is caused by the confluence of a saline tributary upstream which had an EC reading of 67.6 mS/cm (37 180 mg/L).

Other tributaries have stream flow with lower salinity than the river. The EC for Nalyaring Gully (PS5, Pt 18-19) was 13.1mS/cm (7 200 mg/L) and for Sandplain Creek (PS12, Pt 53-54), the EC reading was 17.7 mS/cm (9 735 mg/L).

Figure 1 shows an EC 'dip' for Pt 86 where the reading was 25.8 mS/cm (14 190 mg/L). The lower readings continue down stream to Pt 84 and coincide with extensive 'sand lens' either side of the river suggesting significant fresh seepage.

The salinity of stream flow in the river is influenced by the salt load from tributaries and fresh seepage from 'sand lenses'. In addition, there is significant saline seepage directly into steam flow as a result of rising saline groundwater aquifer levels in the valley floor. It is likely that this is the greatest cause of stream flow salinity in the Aldersyde-Kweda Section of the river.

The nutrient load of stream flow, river pools and sediments is not known.

2.7 Tributaries

The tributary catchments for the Aldersyde-Kweda Section are shown on Map 3. The area, land landscape relief and the gradient length of stream channels for each tributary is shown in Table 6.

All tributaries (with the exception of A) have greater than 0.5% average channel

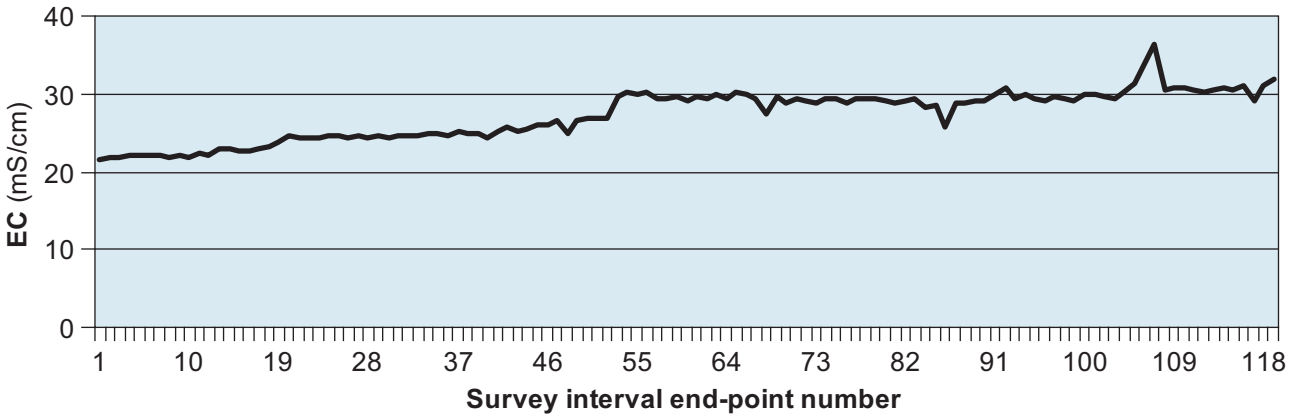


Figure 1. Electric conductivity of streamflow in the Aldersyde-Kweda Section of the Avon River

Table 6: Tributary characteristics for the Aldersyde-Kweda Section

Code	Tributary name	Area (km^2)	Relief (m AHD)	Channel gradient (m/km)	Length (km)
A	No name provided.	16.4	240-220	2.9	6.9
B	Nalyaring Gully	150.8	370-220	5.0	30.0
C	No name provided.	10.0	285-220	11.9	4.7
D	Petercarring Brook	140.0	380-250	9.4	13.9
E	Sandplain Creek	78.3	440-260	9.8	18.4
F	Dwarlacking	40.7	360-260	6.2	16.1
Q	Bulyee – no name provided.	76.8	N/A	N/A	16.0
R	Kweda – no name provided.	38.6	325-240	7.9	10.7

gradient. Three tributaries (C, D and E) have approximately 1% average channel gradient. Each of these has high potential for channel erosion and sediment transport. The combined Petercarring Brook (D) and Sandplain Creek (E) may have greatest potential for sediment discharge to the floodplain.

2.8 River Fencing Condition

The type and condition of fencing on both sides of the river was recorded during the walking survey. Fencing that was of substantial construction (eg 'ringlock' and steel picket materials) built within the past 5-10 years was classified as 'good' condition. Older fences were classified as 'moderate' and an estimate of the remaining effective life of the fence provided (eg a fence classified as M(10) is expected to remain stock-proof for a further 10 years). Fences that are ineffective are classified as 'poor'. Appendix Four shows the condition of fencing along the river section.

A relatively high proportion of the river section has 'good' fencing, some of which is relatively new construction built with materials supplied by the Department of Water. There are only two locations (PS4-5 Pt 17-19 and PS24, Pt 118-119) where there is no fencing on at least one side of the river.

The Photo Section notes identify the areas where fence construction or replacement is proposed. This includes areas without fencing or where the fence classification is either 'poor' or 'moderate (5)'.

Other than where there are no fences on at least one side of the river, there was very little sign of livestock within the river environment. Some landholders have fenced the river but want to graze livestock occasionally to reduce weeds and fire risk.

There are some areas where good fencing has been recently constructed that excludes high value remnant vegetation (eg vegetated 'sand lenses') from the river environment. There are opportunities to locate fencing to substantially increase river values.

The lower reaches of most tributaries are not fenced.

To assist landholders in the Avon River catchment, DoW and ACC developed the Avon Fencing Program, which supplies materials for the fencing of foreshore areas. Landholders whose property lies

adjacent to the Avon River or its tributaries may be eligible for materials to either construct a new fence or replace existing fencing in poor condition. Landholders who receive fencing enter into a voluntary agreement to erect and maintain the fence and only allow limited stock grazing to control weeds. For more information contact the Department of Water, Northam office on (08) 9622 7055.

2.9 Fauna

A list of bird species observed (seen or heard) was recorded for each interval of Photo Sections 12-24 during the river survey. A total of 58 species were recorded during this period (shown in Appendix Five).

The number of species (species richness) provides an index of biological diversity for the avian community. The range of species richness for the survey intervals for which bird census information was recorded (Pt 53-119) was from 0 to 12 species (table in Appendix Five). There are many factors which influence a census of birds (eg wind or rain) so results of a single census for each survey interval is only broadly indicative of biological capacity within the river environment. However, it does provide a comparative measure along the river.

The survey intervals with highest bird species richness were Pt 64-65 (12 species) and Pt 114-115 (11 species). Other locations with 8 or more species were Pt 54-55, Pt 55-56, Pt 56-57, Pt 57-58, Pt &3-74, Pt 90-91, Pt 99-100, Pt 105-106, Pt 106-107, Pt 109-110, Pt 113-114, Pt 115-116 and Pt 118-119. Some of these locations are where salinity has had most effect on the river environment (eg Pt 64-65) although most are where the River Health Index (section 2.12) is 'moderate' or 'good'.

Up to 10 of the bird species observed require tree hollows for nesting, for example Regent Parrot, Elegant Parrot, Tree Martin and Striated Pardalote. The vegetation community has changed from being dominated by a range of species to one that is dominated by swamp sheoak (*Casuarina obesa*). As swamp sheoak does not form effective hollows, the habitat value for these species is diminishing.

Other native fauna species observed were:

- Long-necked tortoise (*Chelodina oblonga*) – 2 observations;
- Bob-tailed lizard (*Tiliqua rugosa*) – very common;
- Grey kangaroo (*Macropus fuliginosus*) – very common;
- Red kangaroo (*Macropus rufus*) – 1 observation;
- Echidna (*Tachyglossus aculeatus*) – diggings, local information; and
- Southern Brown Bandicoot – Quenda – (*Isodon obesulus*) – digging, local information. Unconfirmed observations for the river environment although this species is considered to occur in this river section.

2.10 Weeds and Unwanted Animals

There is a relatively high level of weeds in most Photo Sections although there is considerable variation in the range of weed species within each survey interval. All had at least some annual weed species. These were not recorded separately during the survey as they are unlikely to be managed as individual species. The most commonly occurring annual weeds were annual veldt grass (*Ehrharta langifolia*), perennial veldt grass (*Ehrharta calycina*), barley grass (*Hardeum leparinum*), ryegrass (*Lolium* spp.), cape weed (*Arctotheca calendula*), brome grass (*Bromus* spp.) and wild oats

(*Avena fatua*). Other weeds occurring less commonly were Guildford grass (*Romulea rosea*), sour sob (*Oxalis pes-caprae*) and medics (*Medicago* spp.). Puccinellia (*Puccinellia ciliata*) has established in some sections at the confluence of tributaries. It is beneficial for salt-affected land but not in the river environment.

The weeds that require a high level of management are:

Bridal creeper (*Asparagus asparagoides*) – located at PS 4 (Pt 16-17), PS 5 (Pt 18-19), PS 6 (Pt 27-28), PS 7 (Pt 30-33), PS 8 (Pt 33-38), PS 9 (Pt 39-42), PS 10 (Pt 42-46), PS 12 (Pt 58-59) and PS 13 (Pt 62-64);

Spiny rush (*Juncus acutus*) – located at PS 5 (Pt 18-19), PS 8 (Pt 35-36), PS 10 (Pt 47-48) and PS 11 (Pt 51-52);

Cape tulip (*Homeria* spp.) – located at PS 8 (Pt 37-38), PS 9 (Pt 38-41), PS 10 (Pt 42-45) and PS 11 (Pt 50-51); and

Sour sob (*Oxalis pes-caprae*) – located in Nalyaring Gully and at PS 21 (Pt 96-97), PS 22 (Pt 103-104) and PS 24 (Pt 114-115).

Bridal creeper is particularly significant as it is probably spreading rapidly within the river environment (Photo 21). Down-stream from the Brookton-Corrigin Road bridge, bridal creeper occurs as isolated plants, however up-stream of the bridge, there are extended sections where it is continuous both sides of the river. The occurrence of bridal creeper is substantially reduced up-stream from the Aldersyde Road bridge and was not observed further upstream than PS 13 (Pt 62-63).

Spiny rush (*Juncus acutus*) is also significant because of its capacity to spread rapidly and suppress regeneration of naturally occurring species (Photo 22). It is not currently widespread and can be controlled. It was not recorded upstream of Aldersyde Road bridge in the river system although it was noted to occur in tributaries away from the river near Kweda.

Sour sob (*Oxalis pes-caprae*) and cape tulip (*Homeria* spp.) both had relatively limited distribution at present and can be controlled. For more information please contact the Department of Water, Northam Office on (08) 9622 7055.

Foxes were noted at five locations during the survey by observation of active lairs (Appendix Five, Photo 23). Two of these occurred on the banks of the river at water level, others were in ‘sand lenses’. These were noted at only four locations on the LHS of the river although it is expected that many more fox lairs occur where ‘land lenses’ intersect or are adjacent to the river.

Rabbits were observed at only six locations during the river survey in areas associated with ‘sand lens’ soils (Appendix Five). There were four locations where rabbits occurred that also had observations of foxes. It is likely that the predator/prey relationship is the major control of population size for both of these species within the river environment.

The population size of Australian Ringnecks (also known as 28 parrots) has increased in recent times. It is thought that these displace other species by dominating nesting opportunities in tree hollows.

Laughing Kookaburra were recorded only once during the survey so are probably not common in the area. They have been introduced to the landscape and feed on native species.

2.11 Foreshore Condition Assessment

An assessment of foreshore condition was made for the survey intervals of each Photo Section. This assessment is based on the method proposed by Pen and Scott (1995).

Photo 21: Bridal Creeper in Photo Section 4

Photo 23: Fox lair at water level in Photo Section 9

Photo 22: Spiny Rush on the LHS bank in Photo Section 8

Photo 24: Broad salt-affected channel with dead trees in Photo Section 16

The classification categories are shown below.

A Grade Foreshore	B Grade Foreshore	C Grade Foreshore	D Grade Foreshore
A1 Pristine	B1 Degraded – weed infested	C1 Erosion prone	D1 Ditch – eroding
A2 Near pristine	B2 Degraded – heavily weed infested	C2 Soil exposed	D2 Ditch – freely eroding
A3 Slightly disturbed	B3 Degraded – weed dominant	C3 Eroded	D3 Drain – weed dominant

Assessment during the field survey is based on general assessment of the 500 metre survey interval. The assessment is shown in the notes for each Photo Section. The overall foreshore condition rating for each survey interval is shown in Map 5.

The range of assessment was from B2 to D1. There are no locations that could be classified as ‘pristine’ or ‘slightly disturbed’. The ‘B-grade’ was relevant to the best river condition although weeds were not particularly effective for discrimination between the three classifications in this group. Most survey intervals were classified as C1. Photo Section 16 was worst with most survey intervals having a D1 classification.

Map 5a ALDERSYDE-KWEDA General Foreshore Condition - West

LEGEND

- Pool
- Survey Section Marker
- Town
- Local Road - Sealed
- Hydrography
- Catchment
- Local Government Authority
- Freehold
- Crown Reserve
- Crown Lease
- Unallocated Crown Land

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94
Projection: MGA 94 Zone 50

Project Information

Requestee: Kate Gole
Map Author: Hamish West
Task ID: 6259
File Location: \\Pentecost\gis_projects\RS\Sn\96209\0002\
File Name: map5a_general_foreshore_condition
Date: 22/03/2006

SOURCES

DoE acknowledges the following datasets and their Custodians in the production of this map:

Dataset Name - CUSTODIAN ACRONYM - Metadata Date		
Hydrographic Catchments - Catchments	DoE	23/03/2005
Hydrographic Catchments - Subcatchments	DoE	23/03/2005
Hydrography, linear(hierarchy)	DoE	13/04/2005
Road Centreline, DLI	DLI	01/04/2004
Towns	DLI	08/2004
Cadastre	DLI	01/12/2005
Local Government Authorities	DLI	08/07/2004
CALM Managed Lands and Waters	CALM	01/07/2005

Department of Water
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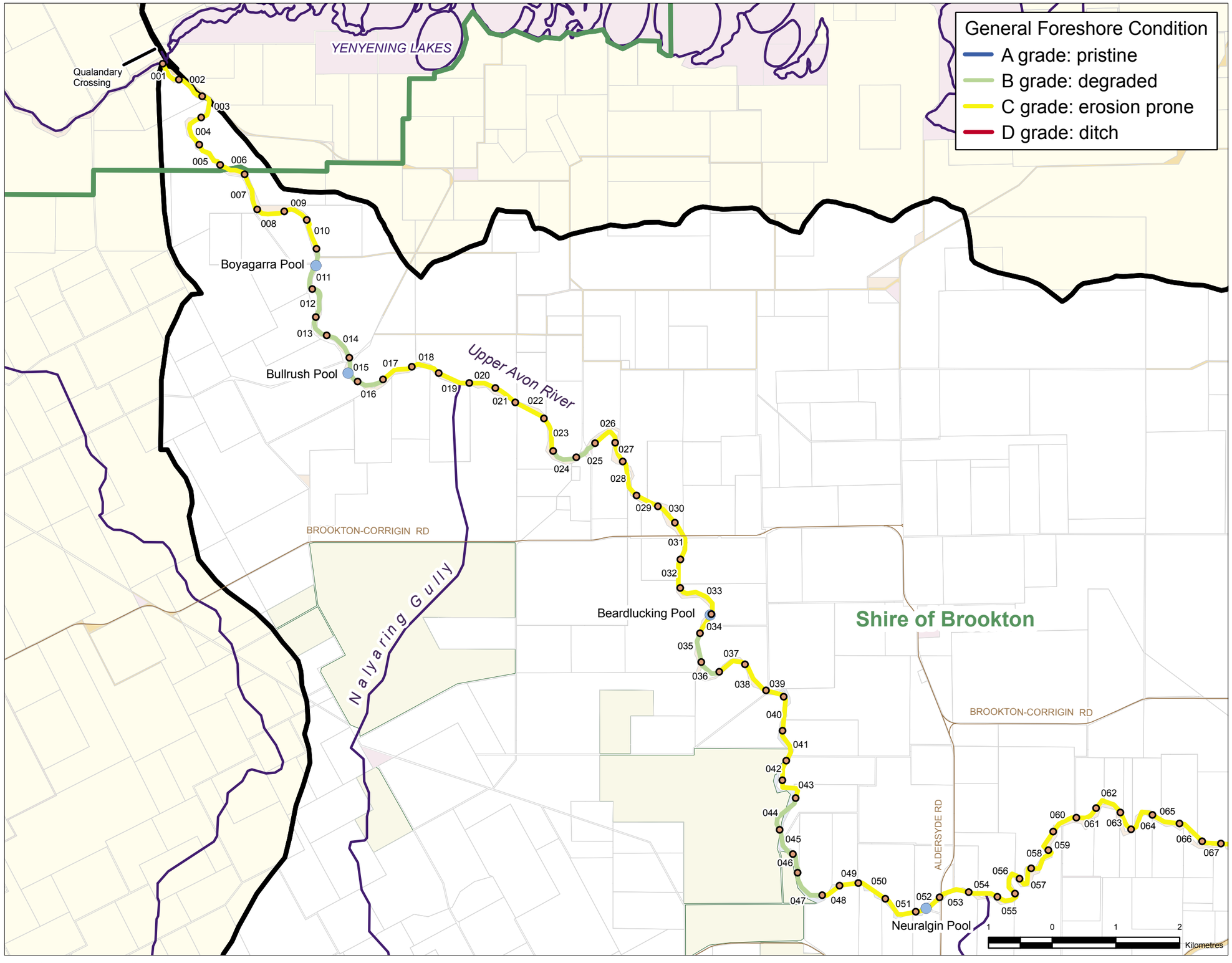

Map 5a: Aldersyde-Kweda General Foreshore Condition - West

Map 5b ALDERSYDE-KWEDA General Foreshore Condition - East

LEGEND

- Pool
- Survey Section Marker
- Town
- Local Road - Sealed
- Hydrography
- Catchment
- Local Government Authority
- Freehold
- Crown Reserve
- Crown Lease
- Unallocated Crown Land

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94
Projection: MGA 94 Zone 50

Project Information

Requestee: Kate Gole
Map Author: Hamish West
Task ID: 6259
File Location: \\Pentecost\gis_projects\RS\Sn\96209\0002\
File Name: map5b_general_foreshore_condition
Date: 22/03/2006

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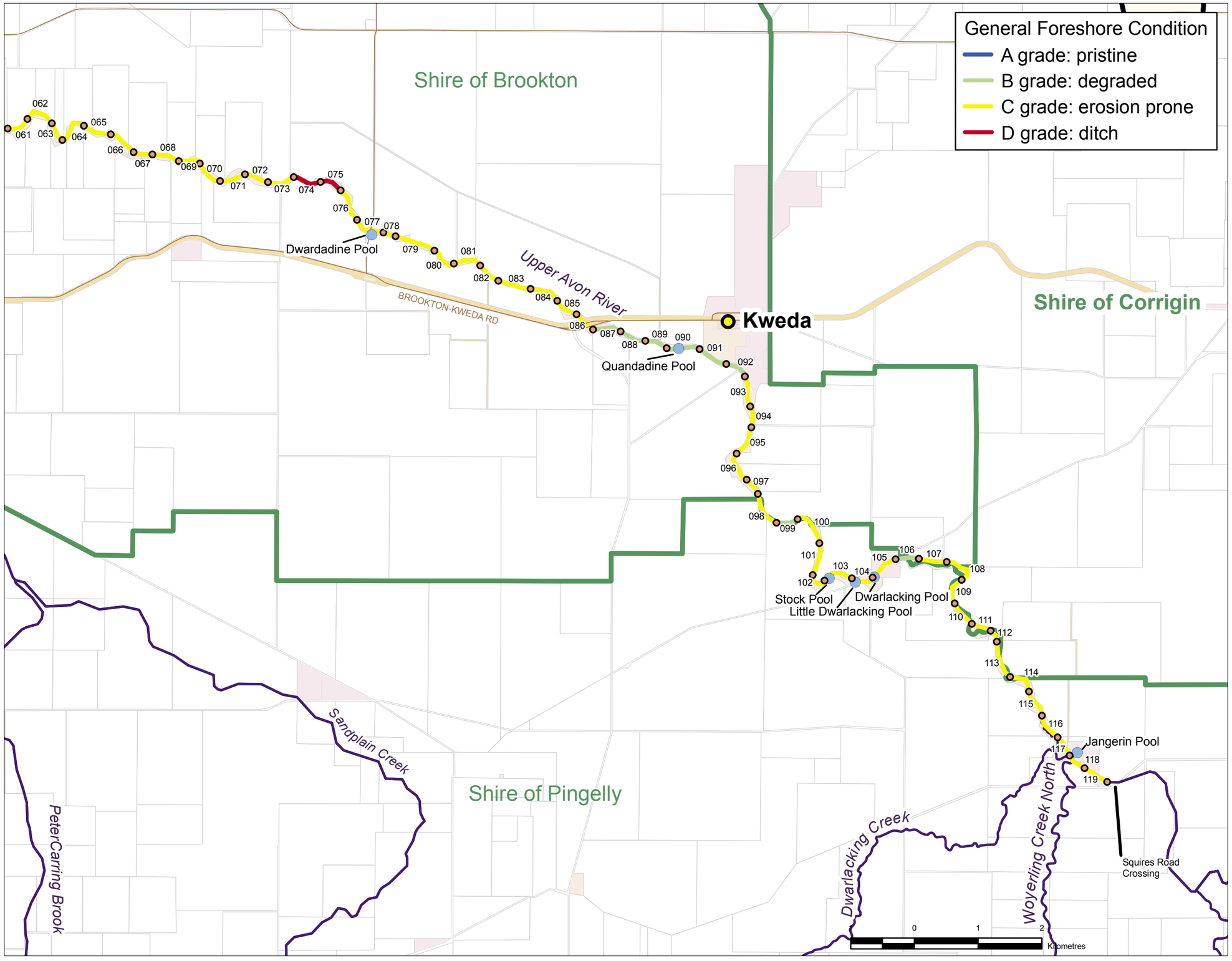

Map 5b: Aldersyde-Kweda General Foreshore Condition - East

2.12 River Health Index

A measure of river health (Overall Environmental Stream Health Rating) was also assessed for survey sections in each Photo Section. The criteria for assessment are show below and are based on the methodology developed by Pen and Scott (1995).

The value of this information is in setting priorities for management for the Aldersyde-Kweda Section of the Avon River. A general principle is to manage the locations that have the highest rating on the bases that protection of existing values is more feasible and cost-effective than actions to recovery values that have been degraded. However, this should be used as a guiding principle only. Some 'poor' or 'very poor' locations may also become a local community priority for management.

The Overall Environmental Stream Health Rating is shown in the notes for each Photo Section and on Map 6. From this information it is clear that the condition of the river varies considerably from 'excellent' to 'very poor' condition. Most survey intervals were of 'moderate' condition.

Rating	Floodway and bank vegetation	Verge vegetation	Stream cover	Bank stability and sediment	Habitat diversity
Excellent	15	8	8	8	6
Good	12	6	6	6	4
Moderate	6	4	4	4	2
Poor	3	2	2	2	1
Very poor	0	0	0	0	0

Surrounding land-use (values below to be summed with the score of the above criteria):

Conservation reserve (8), Rural residential (4), Urban (2), Remnant bush (6), Agricultural (2) and Commercial/industrial (1).

2.13 River Management Issues from the Survey

Key management issues were recorded for each Photo Section during the river survey. Detailed actions for these issues are listed separately in the Photo Section notes. A broader description of these issues in relation the complete Aldersyde-Kweda Section is provided here.

Salinity

The increasing impact of salinity is clearly a major influence on the river environment (Photo 24). Map 4 shows the current extent and further potential for this to occur. Many plant species are senescent and regeneration is limited in most sections. Exceptions occur where 'sand lenses' are adjacent to or intersect the river and contribute fresh seepage to riparian ecosystem.

The Avon River system is located in a broad valley floor where the risk of salinity is greatest in the landscape. The management options to contain the risk of salinity in these systems include broad-scale tree-planting in the floodplain. There are good demonstrations of 'alley' revegetation in the Aldersyde-Kweda Section. Commercial options (including 'oil

Photo 25: High sediment load from tributary on RHS in Photo Section 10

Photo 27: Drain confluence in Photo Section 23

Photo 26: Drain confluence with Dwardadine Pool in Photo Section 16

Photo 28: Confluence with drainage at Pt 84 in Photo Section 18

mallee' species) may be suitable.

The potential to recover the river environment from current salinity impact is limited. Engineering options (drains and groundwater pumping) may be feasible but not cost effective. Any downstream impacts from these options also need to be considered.

Drainage

Some landholders have adopted systems of drainage to tackle farm salinity. The locations where these discharge to the river are identified for each Photo Section. Nine drain systems were noted to discharge to the river environment. These are located in Photo Sections 10, 15, 16, 17, 18, 19, 21 and 24.

One of these drains has capacity to discharge sediment to the river (Photo Section 10, Photo 25). Another drain discharges to Dwardadine Pool (Photo Section 16) which may contribute sediments during high flow events (Photo 26). A sediment delta in the pool due to the drain was not noted, however a survey of pool depth should be undertaken to establish the previous impact of the drain. The drainage confluence in Photo Section 24 occurs in a relatively small section of river bank where soils are dispersive and prone to erosion (Photo 27).

Map 6a ALDERSYDE-KWEDA River Health Index - West

LEGEND

- Pool
- Survey Section Marker
- Town
- Local Road - Sealed
- Hydrography
- Catchment
- Local Government Authority
- Freehold
- Crown Reserve
- Crown Lease
- Unallocated Crown Land

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94
Projection: MGA 94 Zone 50

Project Information

Requestee: Kate Gole
Map Author: Hamish West
Task ID: 6259
File Location: \\Pentecost\gis_projects\RS\Sn\96209\0002\
File Name: map6a_overall_stream_enviro_health
Date: 22/03/2006

SOURCES

DoE acknowledges the following datasets and their Custodians in the production of this map:

Dataset Name - CUSTODIAN ACRONYM - Metadata Date		
Hydrographic Catchments - Catchments	DoE	23/03/2005
Hydrographic Catchments - Subcatchments	DoE	23/03/2005
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Road Centreline, DLI	DLI	01/04/2004
Towns	DLI	08/2004
Cadastre	DLI	01/12/2005
Local Government Authorities	DLI	08/07/2004
CALM Managed Lands and Waters	CALM	01/07/2005

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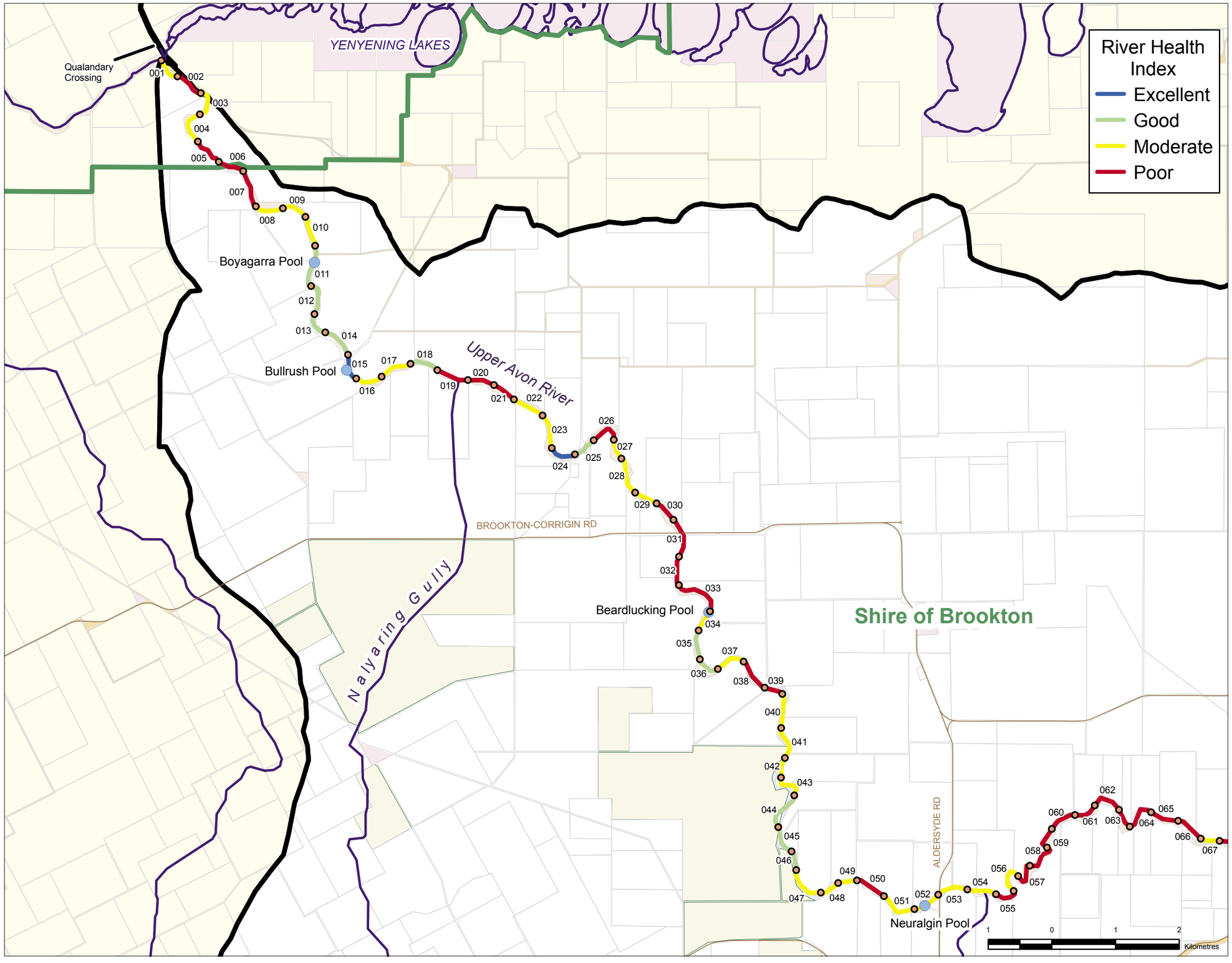

Map 6a: Aldersyde-Kweda River Health Index - West

Map 6b ALDERSYDE-KWEDA River Health Index - East

LEGEND

- Pool
- Survey Section Marker
- Town
- Local Road - Sealed
- Hydrography
- Catchment
- Local Government Authority
- Freehold
- Crown Reserve
- Crown Lease
- Unallocated Crown Land

Datum and Projection Information

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Horizontal Datum: GDA 94
Projection: MGA 94 Zone 50

Project Information

Requestee: Kate Gole
Map Author: Hamish West/Judit Bonisch
Task ID: 6259
File Location: \\Pentecost\gis_projects\RS\Sn\96209\0002\
File Name: map6b_overall_stream_enviro_health
Date: 16/01/2007

SOURCES

DoE acknowledges the following datasets and their Custodians in the production of this map:

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Hydrographic Catchments - Catchments	DoE	23/03/2005
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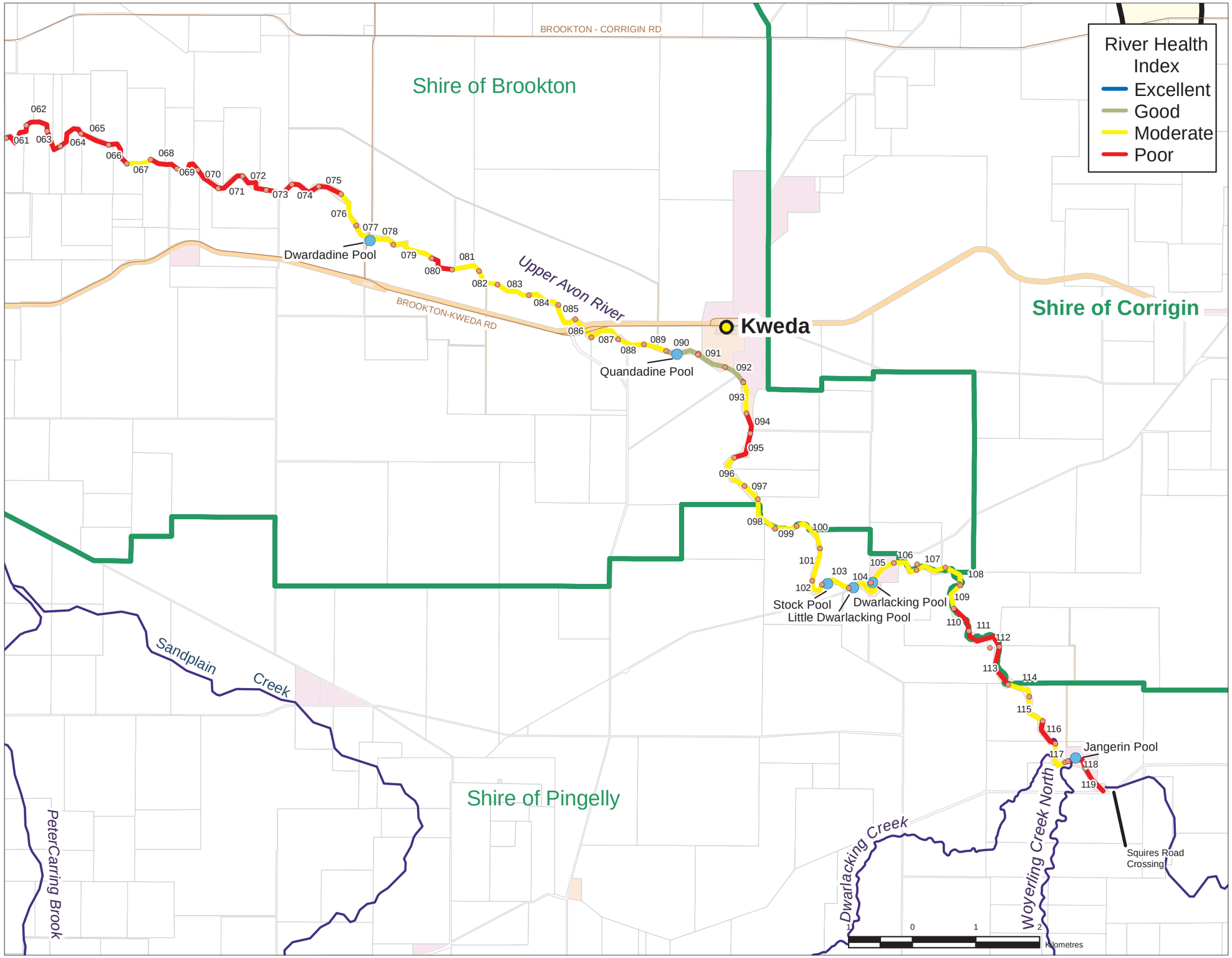

Map 6b: Aldersyde-Kweda River Health Index – East

This may have caused sedimentation during construction although seems now to be relatively stable.

Most drains discharge to floodways or fringing vegetation where sediments are filtered. The drain confluence in Photo Section 18 (Pt 84) is an example of limited impacts and possibly provides some benefit to the river environment (Photo 28). Others discharge to riparian vegetation and may be the cause of increased salinity impact there.

During the period of the survey, there was very low stream flow to the river from all drains observed.

Revegetation

There are three trials of riparian zone revegetation on the river reserve adjacent to Boyagarra Pool and the properties of Kim Mills and Shane and Karen Bowron (Photo 29). These provide an indication of suitable species for revegetation. There are locations identified in Photo Sections where natural regeneration is occurring for a limited range of species, especially where fresh seepage to the river system is occurring. These locations should be given priority for further revegetation effort. One location is identified in Photo Section 7 (Pt 30-32, LHS) which may be suitable for further revegetation trials, including options for weed control and altering conditions to encourage natural regeneration.

There are significant opportunities to add value to the river environment by revegetation of ‘sand lenses’ adjacent to the river. These vary in their current condition. Some have a very low level of weeds and a broad range of species regenerating. Others have been previously cleared and are now degraded and generally unproductive. Further assessment of the ‘sand lens’ vegetation would show which areas should be protected to encourage natural vegetation regeneration, and the areas where revegetation would be beneficial. Some locations are suggested in the Photo Section notes that are considered potentially suitable for establishment of ‘biodiversity sandalwood’ (ie commercial sandalwood trees hosted to locally suitable native species with biodiversity benefit).

Fire Risk

The risk of fire in the river is not identified as a high priority for management by most local landholders although there is concern about the risk to private assets (houses, sheds and sheep yards) in some locations. The fuel load is mostly due to weeds. In these sections, weeds can be reduced by limited grazing according to local ‘best practice’ (ie time and period of grazing).

Road and Farm Crossings

There are eight major road crossings within the Aldersyde-Kweda Section. These all have significant bridge structures and have little effect on the river functions. In some locations, remnants of older bridges no longer in use are near new bridges. A smaller road crossing adjacent to the Brookton-Kweda road (Photo Section 18) is a floodway with small culverts (Photo 30). This has caused sediment to aggregate upstream. Actions to manage this sediment are included in the photo section notes.

There are farm crossings at locations noted in the Photo Section notes. Some are broad floodways with no infrastructure, others are substantial bridge structures (Photos 31 and 32). All crossings were noted as being relatively stable and with limited impact on the river environment.

Public Access

Public road crossings provide opportunities for public access to the river environment. The two locations that have potential for development of these opportunities are

on the LHS upstream from Qualandry Crossing (Photo Section 1) and in the Reserve at Dwarlacking Pool (Photo Section 22).

Rubbish

Locations where there is farm and household rubbish near the river are noted in the photo section notes (Photo 33). Most are discarded fencing materials. Almost all sites were old rubbish disposal sites and not in current use. While rubbish in the river environment may be considered to be unsightly, the major risk is if there is potential for contamination or dangerous flotsam during floods. Most rubbish noted was not a risk to the river environment.

Photo 29: Riparian revegetation on LHS in Photo Section 12

Photo 30: Culvert and Bridge at the Brookton-Kweda Road crossing in Photo Section 18

Photo 31: Farm crossing with low river impact in Photo Section 24

Photo 32: Substantial farm access crossing in Photo Section 18

Photo 33: Rubbish deposition in Section 20

3 Developing the Recovery Plan

The Recovery Plan for the Aldersyde-Kweda section of the Avon River is one of a series of recovery plans developed in association with local communities along the main channel and tributaries of the Avon River system by the Department of Water (Northam Office). This section is closely linked to the River Recovery Plan for the Yealering Lakes Section (DoW, 2006).

3.1 The Planning Process

The recovery planning process commenced with a reconnaissance-scale field survey and an initial meeting (April, 2005) with local community and Shire representatives to provide scope for the range of management issues to be addressed. This was followed by a well-publicised public meeting held the Aldersyde Hall (April, 2005) at which the range of environmental, social and economic values were developed and the key threatening processes identified. A small interim Steering Committee was appointed to provide local direction for the planning process.

The 'vision' and 'management objectives' for the Recovery Plan were developed with the interim Steering Committee and a range of management response actions was proposed during a following meeting (July 2005). Some of the options were assessed in the field on several occasions.

The recommended actions were discussed at a final public meeting held in Aldersyde (November 2005).

The Department of Water has led the planning process with participation by those with interest in the local community, CALM and the ACC. The outcomes expected are to have a Recovery Plan that is understood and endorsed locally, and for a Recovery Team to be formed with local community and government representation and with support from State Government agencies and the ACC.

Photo 34: Boyagarra Pool (Department of Environment)

3.2 A 'Vision' for the future

The 'vision' developed by the interim Steering Committee to provide direction for management actions for outcomes by 2025 is that:

> *'The Aldersyde-Kweda section of the Avon River is managed as a functioning river ecosystem integrated within productive farms. The river channel is fenced for controlled stock access to enable riparian vegetation to regenerate and retain low fire risk. Priority river pools are recovered and maintained for historic, scenic and wildlife values. The risk of salinity in the floodplain is minimised. Weeds and feral animals within the river are controlled. Opportunities for connecting the river environment to adjacent landscapes through natural or constructed corridors are maximised.'*

The 'vision' for the Aldersyde-Kweda Section Recovery Plan combines

environmental and social expectations for the river. It addresses concerns about changing landscapes and seeks new opportunities for reconstructed ecosystems that may provide farm production benefits.

3.3 Key Issues for Management

The key management issues raised through public meeting processes (22 April 2005) are listed in the table below.

Table 7: Key assets, issues and opportunities for management in the Aldersyde-Kweda Section

ASSETS	WORKSHOP COMMENTS
The river channel and floodplain	• The river is valued as a functioning ecosystem. • A considerable proportion of the river is fenced both sides and stock excluded. • The channel was altered as a part of the River Training Scheme from Yenyenning Lakes up to the Aldersyde Bridge.
River Pools	• River pools are valued in this section. They are remembered for social events (eg Mothers Day picnics, duck-shooting trips) and are considered important for water birds. • Boyagarra Pool has been rehabilitated with sediment removal and revegetation. • Dwardadine Pool is relatively large and seems in good condition (thought to have inflow from seeps). • Dwarlaking Pool is thought to have been about 130 m long, 15 m wide and up to 4 m deep. • Names and historic information for other pools required.
Riparian vegetation	• This is valued and there are good examples of natural regeneration and revegetation trials (eg on Shane Bowrons' property). • Some sections have Salmon Gums dominant, others have York Gums. Areas that are becoming salt-affected now have Sheoaks as the dominant tree. • The 'sand dunes' are of interest. They were a source of fresh water (from perched aquifers) but most are now saline. The dunes are unproductive for crops but probably well suited to Maritime Pines or some fodder shrubs.
Major Tributaries	• Valued in their own right. • Foreshore surveys will probably go about 500 m upstream for major tributaries.
Salinity	• The river environment is affected by salinity and the impacts are probably increasing. She-oak (*Casuarina obesa*) and Samphire (*Halosarcia* spp.) are becoming more dominant in places. • The 'Land Monitor' project information shows the distribution of areas at risk to salinity in the valley floor. There are clear geological constrictions that are the cause of salinity in the floodplain and adjacent agricultural land. • Streamflow measured in early April was approximately 18 000 mg/L.
Sediments	• Sediments are not considered to be a major issue, probably as they are being stabilised by couch and samphire. However, some river pools have been filled with sediment and there is no current measure of the extent to which others are at risk.
Weeds	• Bridal creeper, wild oats, cape tulip, spiny rush and sour sob are identified. The introduced bullrush (*Typha* sp.) may also be a problem.
Flow continuity and flooding	• Some areas upstream of the Aldersyde Bridge have restricted channel flow with some localised flooding. • Major floods causing inundation of farmland with salty water is a concern. • The original channel has altered which has affected some farm access. This seems to be an issue in one location.

ASSETS	WORKSHOP COMMENTS
Tributary management	• Some tributaries are eroding and are probably a significant source of sediments to the river.
Fire	• Fire in the river has not been a major issue.
Drainage	• There is interest, but no major drainage programs proposed at present. • One drainage system discharging into Dwardadine Pool but does not seem to be causing sedimentation.
River Crossings and Public Access	• These are not significant issues.
Nutrients and pollution	• There is community concern about the contribution to downstream river ill-health from this area.
Riparian zone vegetation management	• Management of reserves within or near to the river system is important • There is concern about the decline of Wandoo (due to insect damage and/or water stress).
Catchment groups	• Considerable past investment and effort by catchment groups (eg the Dwarlaking Catchment Group. This group has revegetated with one aim being to connect the river to Tutanning reserve for regional biodiversity benefits).
Commercial tree crops	• Maritime pine may be suited to some parts of the floodplain.
Rate concessions	• Areas near the river that are salt affected or fenced for river management are still rated. What opportunities for rate concessions for land used for rehabilitation or conservation?
Involvement by CALM	• Reserves management. • Rare Declared Flora (RDFs), threatened or endangered species (unknown which may occur in this area). • Priority river pool ecosystems.
Orthophotos	• Could arrange these for each landholder (scale 1:10 000).

3.4 Local Management Objectives

The management objects for the Aldersyde-Kweda Section Recovery Plan are:

Objective 1: The river channel is fenced to control livestock access;

Objective 2: Five river pools are maintained as near-natural ecosystems for environmental benefit;

Objective 3: Saline flood flows (1-in-10 year occurrence) are contained in existing or constructed floodways;

Objective 4: Floodplain salinity risk is reduced;

Objective 5: Weeds and unwanted animals in the river environment are eliminated or controlled; and

Objective 6: Five tributaries to the river are managed as reconstructed landscape corridors.

The time period for achieving these Management Objectives is 10 years (ie by 2016).

4 Proposed Management Actions

The actions required to achieve the Management Objectives are listed below. The implementation of all of the following actions is subject to the availability of funding and regional priorities through the ACC Natural Resource Management Strategy and Investment Plans.

Specific actions for Photo Sections are identified in separate notes provided directly to landholders. These are derived from observations during the river survey and are linked to the river management actions listed for each of the objectives below.

The priority for actions and the extent to which each action is implemented should be established by an assessment of *risk* (ie of the threatening processes) and of *feasibility* (ie the potential for the action to effectively achieve the intended outcomes). Some actions for one objective will also contribute to other objectives.

4.1 Proposed Actions for River Channel Management

The Aldersyde-Kweda Section upstream from Qualandary Crossing to the Boyagarra Road Bridge is well documented (UWA Centre for Water Research, 1999). Surveys for ten cross-section transects were used to model sediment transport processes in relation to Boyagarra Pool. Detailed information about the biota (flora and fauna) of the river environment, the flood plain and the pool is also provided for this length of the river.

The river survey has identified locations where the river environment is in good condition and should be protected, and other areas of high priority for management action.

The first management objective is for river fencing. It is expected that additional management objectives for the river channel will be developed following the river survey.

Objective 1: *The river channel is fenced to control livestock access.*

Risk Assessment:

River sedimentation risk is identified from river survey information. Tributaries with high sediment loads (eg Nalyaring Gully and Sandplain Creek) are considered to contribute significantly to the river system. The average channel gradient for Sandplain Creek (and the contributing Petercarring Creek) is almost 1% so the potential for sediment transport in this waterway is high.

Proposed Actions:

1. Develop ‘local best practice’ guidelines, cost-share arrangements and local distribution of materials for fence construction in priority areas;
2. Develop ‘local best practice’ for limited use of grazing for fire risk reduction in the river environment near valued assets; and
3. Monitoring for plant regeneration, sediments, weeds, and fire risk.

Feasibility Assessment:

Fencing is the most cost-effective way of enabling natural regeneration and protecting riparian revegetation (see pages 22 and 23 for information on the Avon Fencing Program). It also allows for controlled grazing for fuel load reduction in area with fire risk. Fire is not currently considered to be a major issue for management.

4.2 Proposed Actions for River Pool Management

The survey, analysis and management planning for Boyagarra Pool (UWA Centre for Water Research, 1999) demonstrates methods for river pool management. The information collated and analysis methods were undertaken as tertiary student projects resulting in comprehensive reporting. From this information, a reduced set of information and analysis methods for other pools can be developed. The management plan for Boyagarra Pool provides a suitable template for other river pools.

The river pool management objective is for five of the seven identified pools to be recovered and maintained as near natural ecosystems. The local priority for pool recovery is:

Boyagarra Pool, Dwarlaking Pool, Dwardadine Pool, Quandadine Pool and Jangerin Pool Section 2.5 provides information about the pools from the river survey. This information should be considered with local priorities for management.

Dwarlaking Pool is of particular local interest as it occurs within a Reserve and the risk of sediment infill during floods is considered to be low. The local community would like the depth of this pool to be increased. The opportunity to link management of this pool with two other pools downstream is outlined in Section 2.5 and the notes for Photo Section 22.

Objective 2: *Five river pools are maintained as near-natural ecosystems for environmental benefit.*

Risk Assessment:

The condition of most river pools is not well known (with the exception of Boyagarra Pool). The risk of sedimentation of pools may be moderate but increased by drainage or altered flood flows.

The pools probably have water quality issues (nutrients, salinity). These will vary depending upon groundwater (seepage to the pools) and surface water (tributaries direct to the pools or immediately upstream) inflow.

Proposed Actions:

The actions proposed for river pool management are:

1. Collate historic information about the condition and use of each river pool;
2. Undertake a river pool condition assessment (sediment volume, water depth, water quality and fringing vegetation condition);
3. Review management options demonstrated at Boyagarra Pool for specific application to other priority pools;
4. Management action plans for top 5 priority pools (to include revegetation, sediment management, weeds, drainage discharge, nutrient filtering and private/public access). Note – a Management Plan for Boyagarra Pool is complete;
5. Develop cost-share arrangements for proposed pool management actions; and
6. Initiate routine monitoring for water quality (to measure seasonal difference), vegetation condition and wildlife use.

Feasibility Assessment:

The works undertaken for recovery of Boyagarra Pool provide a basis for assessment of the effectiveness of similar works for other pools. The pool environment has been fenced, a buffer zone revegetated with recommended

species and sediments dredged from the pool.

Dredging of sediments is a costly action that provides short-term benefits through increased pool depth and reduced pool nutrient load. The effectiveness of this action depends upon the rate of subsequent sediment infill. It is understood that the potential for this to occur is during flood events (greater than 1-in-20 year ARI). The potential for further infill also depends upon the load of un-stabilised sediments upstream from the pool or from tributaries with confluence upstream from the pool.

4.3 Proposed Actions for Saline Flood Flows

The aerial photographs of the Aldersyde-Kweda Section of the Avon River (Appendix One) show extensive areas at risk to salinity and localised flooding. Table 1 lists these areas for each of the Photo Sections. The areas considered to be at greatest risk are Photo Sections 12-15, 17, 21-22 and 24. Locations where flood flows deviate from the main channel ('anabranches') are also identified for each Photo Section. Some are alternative flow channels with no or low risk whilst others cause localised flooding. Remnants of significant former meanders are also identified ('oxbows'). Some of these are at risk of flooding and to salinity.

There are some locations where localised flooding occurs relatively frequently. Photo Sections 12-15 are initially identified at risk. Flooding causes soils to waterlog and increases the risk of salinity. While the function of the floodplain for flood detention needs to be retained, opportunities to enhance or reconstruct floodways are to be considered. Flood flows in high risk areas are to be mapped based on local knowledge. Options for diversion of these flows to existing floodways are to be assessed. If these options are not available, floodways could be constructed as stabilised broad-based shallow drains or 'spoon' drains. The options and design criteria require detailed on-site assessment.

Objective 3: *Saline flood flows (1-in-10 year occurrence) are contained in existing or constructed flood ways.*

Risk Assessment:

The floodplain exists to contain floods but flood waters are now more saline and affect farm productivity. Large flood events can't be avoided, but smaller flows can be controlled to reduce salinity and waterlogging of agricultural land.

Proposed Actions:

The actions proposed to manage saline flood flows are:

1. Map productive areas prone to localised saline flow flooding to show flow pathways;
2. Map existing river channels and flood ways, and assess their flow capacity (which may be restricted by sediments, snags, weeds or debris);
3. Evaluate flow constriction management options (including minimal sediment removal);
4. Plan for additional constructed flood ways to contain 1-in-10 year floods where flood risk to productive land occurs;
5. Arrange statutory and group approval for construction of planned flood ways;
6. Develop cost-share arrangements for implementation of proposed works; and
7. Monitor flood control effectiveness and condition of existing or constructed flood ways.

Feasibility Assessment:

Altering flood flows within the floodplain of a river is not without risk. There is potential to transfer problems by increased flooding downstream. There is also the risk of earthworks eroding, contributing to sediment load in the river. Design for works to alleviate localised flooding during events with an average recurrence interval (ARI) of 1-in-10 years or less in this section of the Avon River should not cause high risk. However, it is important to ensure that proposed flood mitigation works are planned for the complete river section (rather than for separate sites) so that design criteria includes the potential for cumulative impacts if all possible works were implemented.

4.4 Proposed Actions for Flood Plain Salinity Risk

The potential for salinity in the floodplain is identified for Management Objective 3. The extent of salinity risk and the time before full impact of salinity is not established for the Upper Avon river sections. There is currently no groundwater monitoring or other risk assessment for salinity in the valley floor of the Aldersyde-Kweda Section of the Avon River.

The options for floodplain salinity risk reduction (in addition to control of localised flooding) include revegetation, soil management, drainage and groundwater pumping. Agricultural land that has become salt-affected may be suitable for productive grazing though established salt-tolerant shrubs and pastures.

Revegetation with potentially commercial species is currently adopted in some areas and is suitable for further implementation. Oil mallees (a range of eucalyptus species) established in wide-spaced alleys is well demonstrated in the Upper Avon floodplain. Maritime pine (*Pinus pinaster*) is suitable on deep sandy soils, including the sand lenses of the floodplain (an example area is on Turner's property). Brushwood (*Melaleuca uncinata*) may be suitable in some seepage areas. Riparian zone revegetation using locally occurring species (or similar) is also an option.

Soil management options include increasing infiltration capacity by improving soil structure, and increasing plant growth potential through waterlogging control.

Engineering options are to be considered in relation to on-site benefits and potential off-site impacts. Drains can be constructed to minimise sediment transport but may discharge water that is highly saline or acidic. The risk of this to the riverine environment, including pools, needs to be assessed. Groundwater pumping does not present a sediment risk but may discharge water that impacts on environmental values.

Floodplain salinity risk is expected to be high. The management objective to reduce this risk is ambitious and will possibly require extensive implementation of intervention actions. The benefits to agricultural production and the river need to be greater that the potential impacts.

Objective 4: *Floodplain salinity risk is reduced*

Risk Assessment:

Extensive areas of the floodplain are salt-affected and there is potential for this to increase significantly in some areas. The time and extent of full impact is currently not known.

Proposed Actions:

The proposed actions for floodplain salinity risk reduction are:

1. Assess and map floodplain salinity risk (eg field survey, geophysics, palaeo-drainage identification), and identify priority areas for salinity risk reduction;

2. Map 'sand lenses' within salinity risk areas;
3. Evaluate commercial revegetation options;
4. Identify 'sand lenses' suitable for revegetation for perched aquifer control (eg natural or commercial species);
5. Map floodplain soils and evaluate soil management options;
6. Assess engineering options for benefit to agricultural land and the river (eg drains and groundwater pumping); and
7. Monitor groundwater levels and other indices of salinity risk.

Feasibility Assessment:

The feasibility of all salinity management options remains relatively uncertain because of variable site conditions. All suggested options required detailed sites assessment. Evaluation of all proposed actions should consider the potential for both on-site and off-site benefits and impacts.

4.5 Proposed Actions for Weeds and Unwanted Animals

The occurrence of weeds and unwanted animals in the river environment, including rabbits and foxes, is currently not considered a major risk to agricultural land by neighbouring landholders. There is local concern about cape tulip (*Homeria* spp.) and sour sob (*Oxalis pes-caprae*), both being declared weeds under the *Agriculture and Related Resources Protection Act (1976)* for which landholders are required to take action for control. The location of these and other significant weeds are identified in Section 2.10 and in notes for Photo sections.

Management of bridal creeper (*Asparagus asparagoides*) should be a high priority. Guidelines for management can be found at the following website: <http://www.weeds.crc.org.au/documents/wmg_bridal_creeper.pdf>.

Spiny rush (*Juncus acutus*) has potential to impede stream flow in the river channel and tributaries. It is difficult to control when established in the river. Control methods are laborious but are worth the effort if there is potential for success. Healthy riparian vegetation will reduce available light which inhibits spiny rush growth.

Salt water couch (*Paspalum vaginatum*) is a coloniser of unconsolidated sands in the river channel. When established, it is very effective in stabilising coarse sediments and trapping mobile sediments. The spread of this introduced perennial plant within the river system is significant in reducing the risk of further erosion of the river channel and sedimentation of river pools. The river survey shows that it currently has very limited distribution in the Aldersyde-Kweda Section.

There is some local concern that couch will impede stream flow, trap sediments and lead to localised flooding. However, the couch should form islands interspersed by smaller stream flow channels. The channels will be retained by the erosive power of the faster flowing water and the full channel would not become significantly restricted.

Control of rabbits and foxes should be by current local best practice. Locations where they were noted during the river survey are shown in Appendix Five. There are opportunities for these efforts to be coordinated along the river through the proposed Recovery Team.

Objective 5: *Weeds and unwanted animals in the river environment are eliminated or controlled.*

Risk Assessment:

Weeds and unwanted animals are not considered to be major problems at

present. Some identified weeds have potential to increase without control. Some species can be eliminated.

Proposed Actions:

Proposed actions for management of weeds and unwanted animals are:

1. Map the occurrence of weeds and unwanted animals in the river environment in priority areas identified during the river survey;
2. Plan for eradication of bridal creeper and spiny rush;
3. Plan for control of other identified weeds and unwanted animals; and
4. Monitor for weed or animal outbreak or reduction.

Feasibility Assessment:

Eradication of bridal creeper (*Asparagus asparagoides*) is difficult to achieve, however it spreads rapidly in the river environment and should be eliminated where it occurs. Spiny rush (*Juncus acutus*) is difficult to control or eliminate. Management actions should be focused on pre-empting its establishment by enabling natural regeneration or revegetation of riparian vegetation to create low light conditions which are not suitable for Spiny rush. This should be a priority in the lower reaches of tributaries.

4.6 Proposed Actions for Reconstructing Tributaries as Landscape Corridors

The confluences of the eight major tributaries to the Aldersyde-Kweda Section of the Avon River are identified for each Photo Section. Physical characteristics of these tributaries are listed in Table 6 showing some to be of relatively steep channel gradient.

Management of the relatively small tributary that flows to Boyagarra Pool (Tributary A) is considered important for on-going maintenance of the pool. Nalyaring Gully (Tributary B) has a large catchment area and is relatively steep. It is noted for having a high sediment load. Tributary C has localised flooding issues near the confluence. The combined area of Petercarring Creek and Sandplain Creek (Tributaries D and E) is the largest of all catchment areas and the channel gradient relatively steep. Dwarlacking Creek (Tributary F) has had significant previous restoration work to connect the river with Tutanning Reserve. Tributary R includes reserves adjacent to the Town of Kweda.

The initial priorities for tributary reconstruction are Dwarlacking Creek, Sandplain Creek, Nalyaring Gully, Kweda catchment (Tributary R) and Bulyee catchment (Tributary Q).

Priority actions within tributaries for river management benefit should be focused on sediment reduction and weed control. Opportunities to filter sediment from stream flow by discharge to vegetated sections of the floodplain should be considered. Revegetation of the lower reaches of tributaries to suppress weed establishment is also a priority.

Landscape mapping for each tributary would demonstrate the potential biodiversity benefits by connecting the river with private remnant vegetation or conservation reserves.

Objective 6: *Five tributaries to the river are managed as reconstructed landscape corridors.*

Risk Assessment:

Localised flooding occurs in some tributaries due to sedimentation of lower channel sections caused by removal of riparian vegetation. This has also fragmented biodiversity values in the landscape.

Proposed Actions:

The actions proposed for tributary management are:

1. Prioritise tributaries based on flooding risk, sediment load, weed threat and landscape linkage;
2. Review management options adopted for Dwarlaking Catchment with respect to application in other tributary catchments;
3. Prepare landscape management plans for four other priority tributaries reconstructed landscape corridors;
4. Develop cost-share arrangements for implementing landscape corridors; and
5. Monitor the lower section channel condition of tributaries and the increasing biodiversity values of corridors.

Feasibility Assessment:

Survey of the tributary channels and fringing vegetation will identify the requirements for management of sediments, flooding and weeds. Landscape mapping for each of the priority tributaries will show the extent to which conservation assets can be connected through corridor developed.

The additional biodiversity value of corridors in the Wheatbelt is being assessed in the Shire of Kellerberrin (undertaken by CSIRO Sustainable Ecosystems for *Wallatin Wildlife and Landcare Inc*).

5 Implementation of the Recovery Plan

The proposed lead role for implementation of actions for each Management Objective of the Aldersyde-Kweda Section Recovery Plan is identified in Table 8.

A Recovery Team is to be formed to coordinate implementation of actions of the Recovery Plan. The Department of Water (DoW) has provided leadership in preparation of the Recovery Plan and will continue to take a key role for implementation. In a similar way, the Department of Conservation and Land Management (CALM) has a key role for implementation.

The Aldersyde-Kweda Section Recovery Plan should be linked with the following management plans or initiatives:

- River Recovery Plan for Yealering Lakes Section 20 (DoW, 2006);
- Yenyening Lakes Management Strategy 2002-2012 (WRC and CALM, 2002);
- Management of the Tutanning Nature Reserve and reserves (CALM);
- Existing catchment and Landcare groups (Brookton LCDC);
- The Avon River Basin NRM Strategy and Investment Plan (ACC, 2005); and
- Management Plan for the Rehabilitation of Boyagarra Pool (UWA Centre for Water Research, 1999).

Partnership arrangements between the proposed Aldersyde-Kweda River Recovery Team and the Avon Catchment Council should be developed for investment in regional-scale management of the Aldersyde-Kweda section of the Avon River and associated catchments.

Table 8: Proposed Actions and lead roles for the Aldersyde-Kweda Section Recovery Plan

Objective 1: *The river channel is fenced to control livestock access.*			
Code	**Action**	**Lead role**	**Comments**
1.1	Develop 'local best practice' guidelines, cost-share arrangements and local distribution of materials for fence construction in priority areas.	AKRT/ DoW	Interim Steering Committee to prepare local fencing practice guidelines.
1.2	Develop 'local best practice' for limited use of grazing for fire risk reduction in the river environment near valued assets.	AKRT/ DoW	Valued assets with fire risk to be identified during river survey.
1.3	Monitoring for plant regeneration, sediments, weeds, and fire risk.	DoW/ AKRT	Monitoring sites to be referenced to Photo Sections.

Objective 2: *Five river pools are maintained as near-natural ecosystems for environmental benefit.*

Code	Action	Lead role	Comments
2.1	Collate historic information about the condition and use of each river pool.	AKRT	UWA Centre for Water Research (1999) documents contain relevant information.
2.2	Undertake a river pool condition assessment (sediment volume, water depth, water quality and fringing vegetation condition).	DoW	Standard survey procedure undertaken in a way that can be repeated for comparision.
2.3	Review management options demonstrated at Boyagarra Pool for specific application to other priority pools.	DoW	Re-survey of the pool following dredging may be required.
2.4	Management action plans for top five priority pools (to include revegetation, sediment management, weeds, drainage discharge, nutrient filtering and private/ public access). Note – Management Plan for Boyagarra Pool is complete.	DoW	Four management actions plans could be prepared as one project and reported in a single document.
2.5	Develop cost-share arrangements for proposed pool management actions.	AKRT/ DoW	Based on arrangements for Boyagarra Pool.
2.6	Initiate routine monitoring for water quality (to measure seasonal difference), vegetation condition and wildlife use.	DoW	AKRT member involvement in monitoring.

Objective 3: *Saline flood flows (1-in-10 year occurrence) are contained in existing or constructed flood ways.*

Code	Action	Lead role	Comments
3.1	Map productive areas prone to localised saline flow flooding to show flow pathways.	AKRT	Crop and pasture growth in spring will provide information to support ground mapping.
3.2	Map existing river channels and flood ways, and assess their flow capacity (which may be restricted by sediments, snags, weeds or debris).	DoW	
3.3	Evaluate flow constriction management options (including minimal sediment removal).	AKRT/ DoW	Potential off-site impacts need to be considered.
3.4	Plan for additional constructed flood ways to contain 1-in-10 year floods where flood risk to productive land occurs.	AKRT/ DoW	Detailed works design is required.
3.5	Arrange statutory and group approval for construction of planned flood ways.	AKRT	
3.6	Develop cost-share arrangements for implementation of proposed works.	AKRT/ DoW	
3.7	Monitor flood control effectiveness and condition of existing or constructed flood ways.	DoW/ AKRT	Include measures of crop and pasture productivity.

Objective 4: *Floodplain salinity risk is reduced.*

Code	Action	Lead role	Comments
4.1	Assess and map floodplain salinity risk (eg field survey, geophysics, palaeo-drainage identification), and identify priority areas for salinity risk reduction.	DoW	Detailed geophysical survey techniques may be required. Review of those used in the Shires of Tammin and Kellerberrin will provide useful direction. Obtaining a 1:10 000 scale ortho-photo for each property is recommended.
4.2	Identify 'sand lenses' suitable for revegetation for perched aquifer control (eg natural or commercial species).	AKRT	Use of aerial photos and ground survey.
4.3	Evaluate commercial revegetation options.	GAWA/ AKRT	Bus tour of demonstration sites proposed.
4.4	Revegetate 'sand dunes for perched aquifer control (eg natural or commercial species).	AKRT	Individual landholder decisions. Priority for areas with salinity risk reduction benefits.
4.5	Map floodplain soils and evaluate soil management options.	AKRT	Support for detailed soils mapping to be sought from DAWA.
4.6	Assess engineering options for benefit to agricultural land and the river (eg drains and groundwater pumping).	DoW/ AKRT	Link to assessments in the Engineering Evaluation Initiative (EEI) and Catchment Demonstration Initiative (CDI).
4.7	Monitor groundwater levels and other indices of salinity risk.	DoW/ AKRT	Monitoring wells to be established following salinity risk assessment.

Objective 5: *Weeds and unwanted animals in the river environment are eliminated or controlled.*

Code	Action	Lead role	Comments
5.1	Map the occurrence of weeds and unwanted animals in the river environment in priority areas identified during the river survey.	AKRT	Advice available from the 'Environmental Weeds Action Network'.
5.2	Plan for eradication of bridal creeper and spiny rush.	AKRT	Experience with bridal creeper control through the Toodyay Friends of the River.
5.3	Plan for control of other identified weeds and unwanted animals.	AKRT	Current practice coordinated for the river section.
5.4	Monitor for weed or animal outbreak or reduction.	AKRT	Coordinated annual monitoring recommended.

Objective 6: *Five tributaries to the river are managed as reconstructed landscape corridors.*

Code	Action	Lead role	Comments
6.1	Prioritise tributaries based on flooding risk, sediment load, weed threat and landscape linkage.	DoW/ AKRT	Engagement of landholders within the tributaries is required for implementation.
6.2	Review management options adopted for Dwarlaking Catchment with respect to application in other tributary catchments.	AKRT	Records and photos of actions taken would be useful for others.
6.3	Prepare landscape management plans for four other priority tributaries for reconstructed landscape corridors.	CALM/ AKRT	Review plans prepared for other catchments (including the Wallatin Catchment in the Shire of Kellerberrin).
6.4	Develop cost-share arrangements for implementing landscape corridors.	AKRT/ CALM	Link to existing cost sharing arrangements for Tutanning Reserve.
6.5	Monitor the lower section channel condition of tributaries and the increasing biodiversity values of corridors.	AKRT/ CALM	Monitoring of sediment load would assist river management.

Abbreviations:

AKRT Aldersyde-Kweda Recovery Team

CALM Department of Conservation and Land Management

DAWA Department of Agriculture Western Australia

DoW Department of Water

GAWA Greening Australian Western Australia

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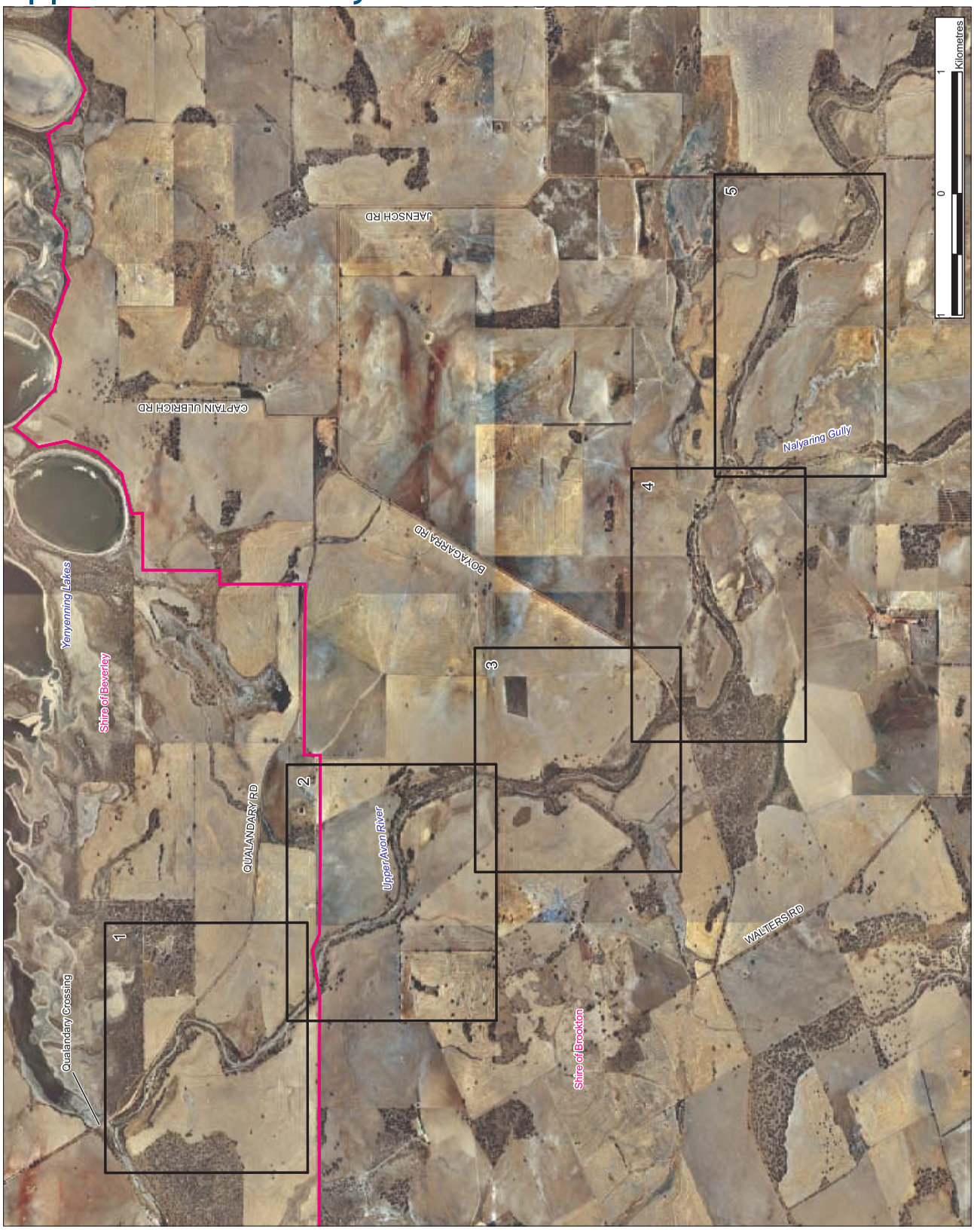
Appendix 1 – Aldersyde-Kweda Photo Sections



Aldersyde-Kweda Photo Sections 1 to 5

Appendix 1b
ALDERSYDE-KWEDA
Photo Sections 6 to 11

SOURCES

DoE acknowledges the following datasets and their Custodians in the production of this map:

Dataset Name - CUSTODIAN	ACRONYM - Metadata Date
Local Government Authorities	DLI 08/07/2004
Corrigin_N_01_1p4m_I	DLI 2001

LOCALITY MAP

N

LEGEND

Local Government Authorities

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94

Project Information

Requestee: Kate Gole
Map Author: Hamish West
Task ID: 6259
File Location: \\Pentecost\gis_projects\RSI\rs962090002\
File Name: appendix_1b_no6-11
Date: 20/04/2006

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Government of Western Australia

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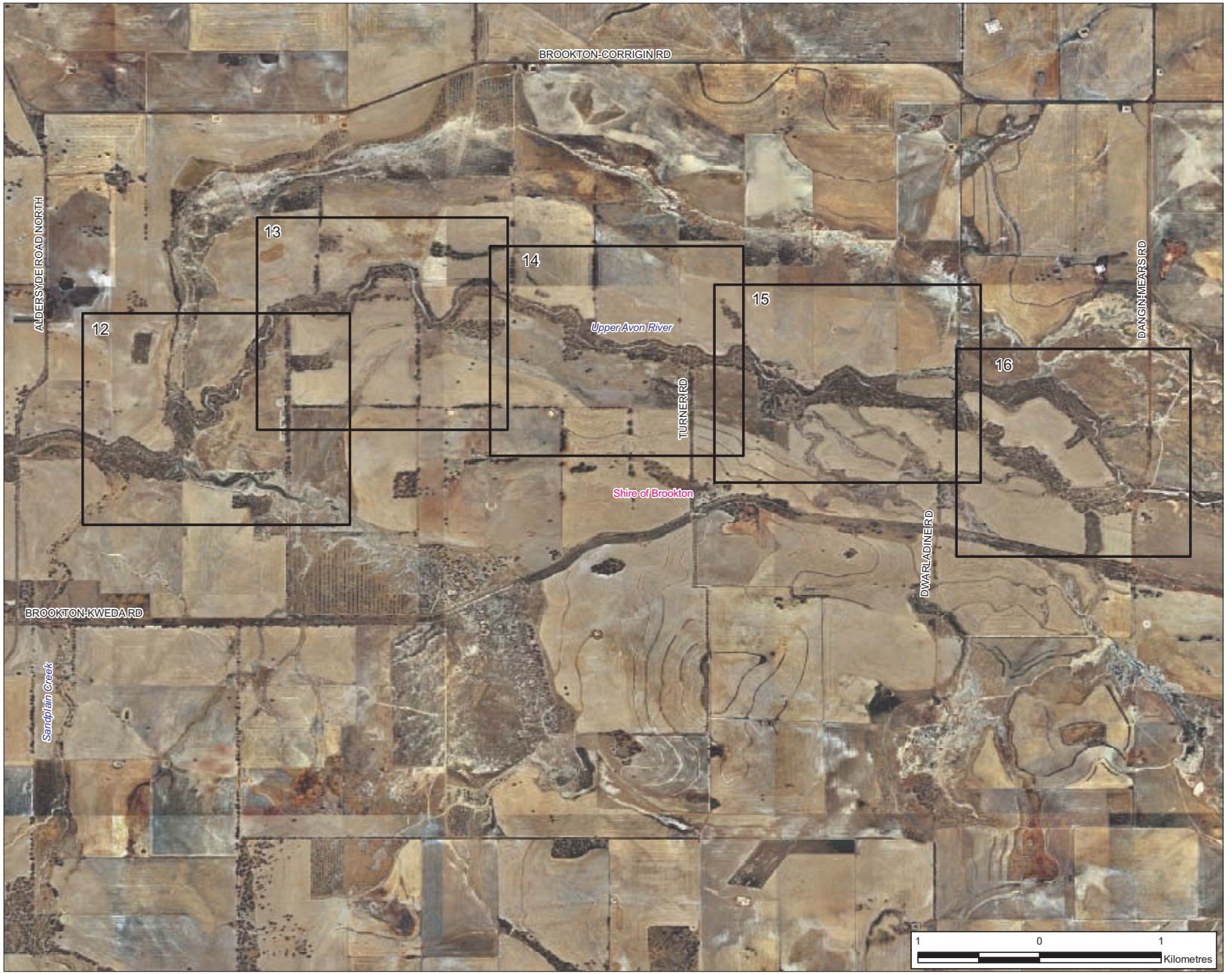
Aldersyde-Kweda Photo Sections 6 to11

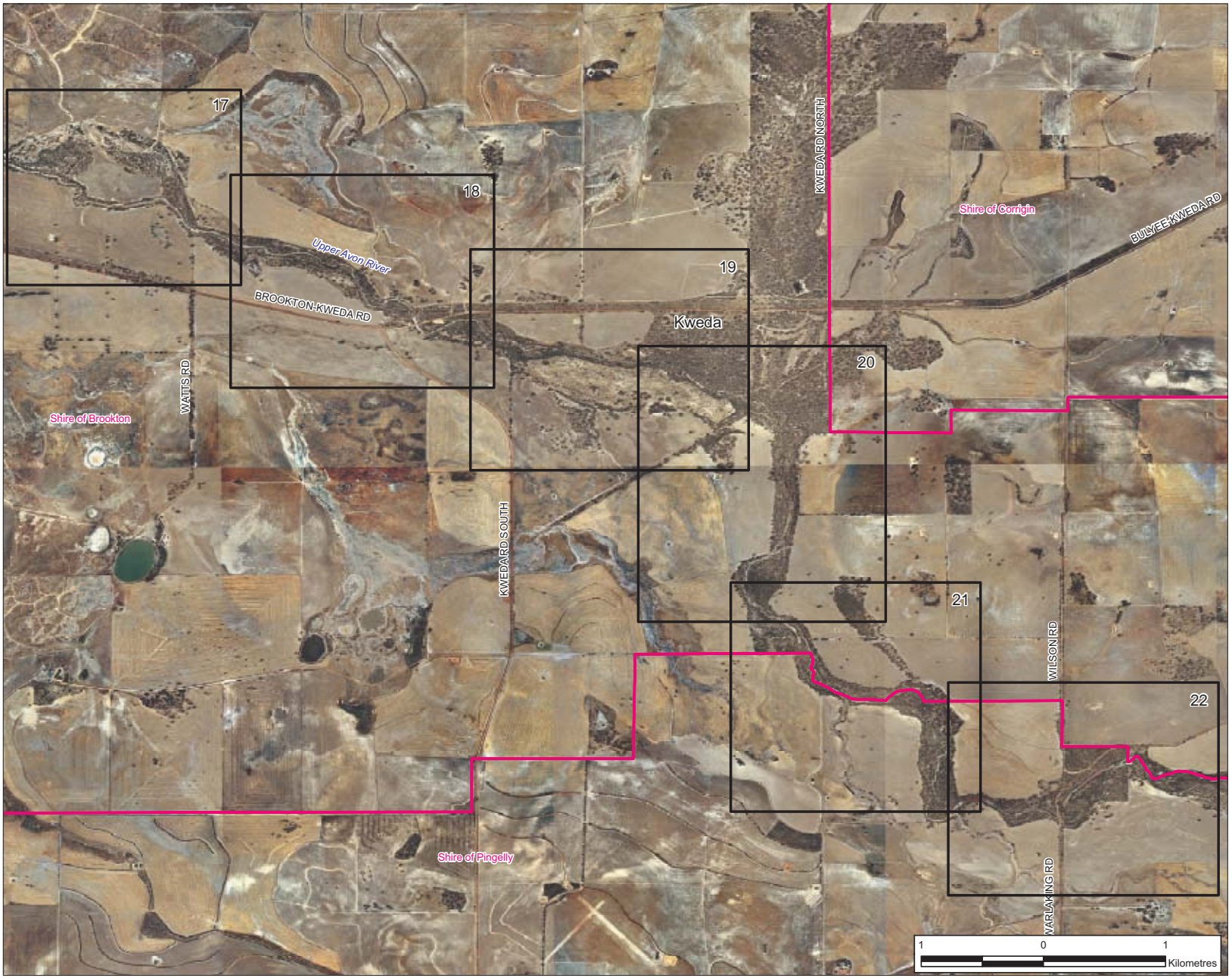
Appendix 1c
ALDERSYDE-KWEDA
Photo Sections 12 to 16

Aldersyde-Kweda Photo Sections 12 to 16



Appendix 1d
ALDERSYDE-KWEDA
Photo Sections 17 to 22

Aldersyde-Kweda Photo Sections 17 to 22



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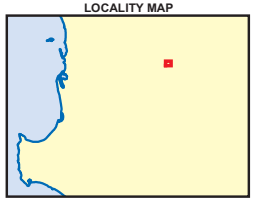

LEGEND

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File Name: appendix_1d_no17-22
Date: 20/04/2006

SOURCES

DoE acknowledges the following datasets and their Custodians in the production of this map:

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Local Government Authorities	DLI	08/07/2004
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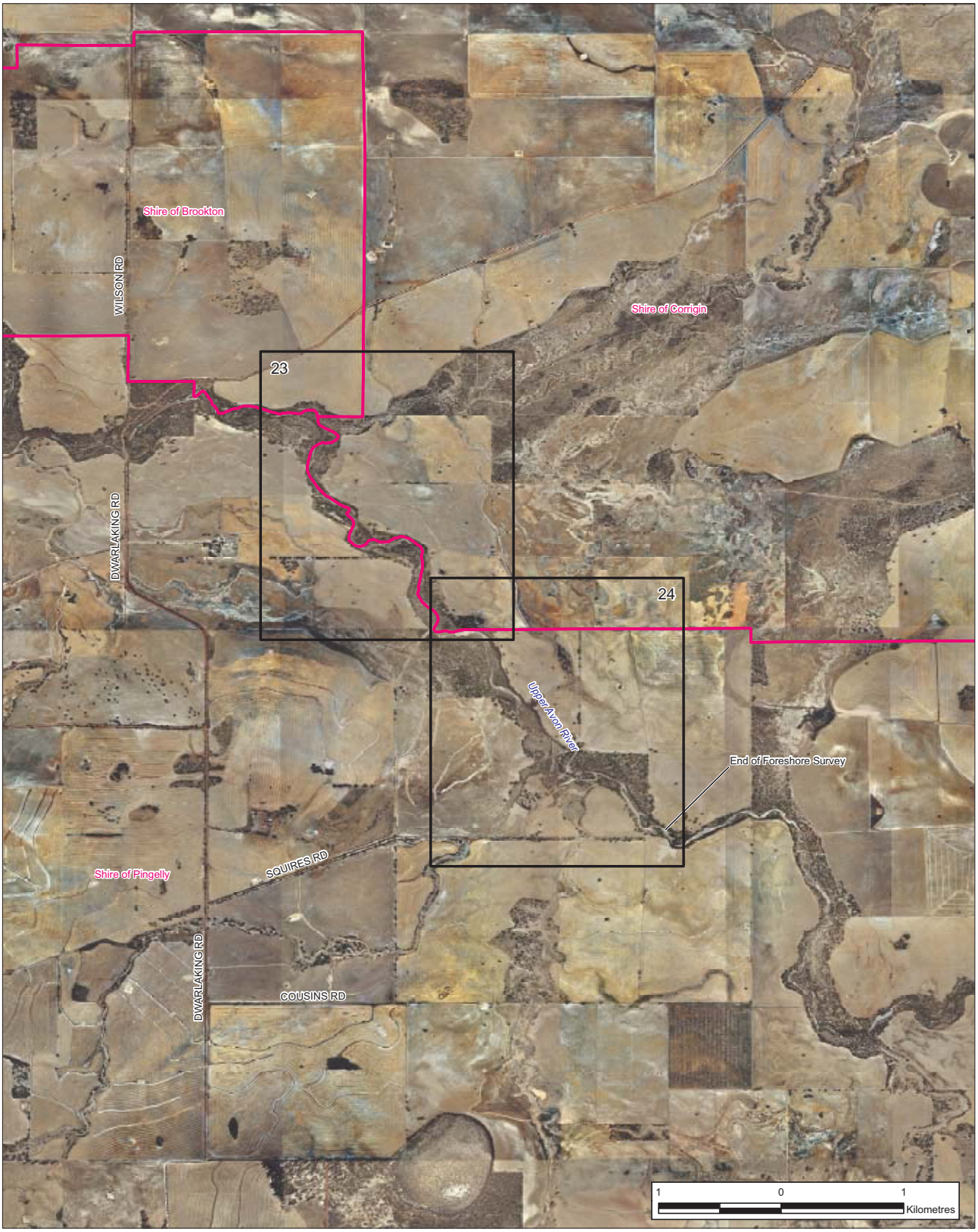
Appendix 1e
ALDERSYDE-KWEDA
Photo Sections 23 to 24



SOURCES

DoE acknowledges the following datasets and their Custodians in the production of this map:

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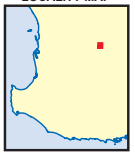
LOCALITY MAP



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LEGEND

Local Government Authorities

Datum and Projection Information

Vertical Datum: AHD
Horizontal Datum: GDA 94

Project Information

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Map Author: Hamish West
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File Name: appendix_1e_no23-27
Date: 20/04/2006

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Aldersyde-Kweda Photo Sections 23 to 24

Appendix 2 – Aerial and assessment notes

Appendix 2
ALDERSYDE-KWEDA
Aerial Photo 1

N

LOCALITY MAP

LEGEND
Survey Section Marker
Cadastre
Local Government Authority

Datum and Projection Information
Vertical Datum: AHD
Horizontal Datum: GDA 94

Project Information
Requestee: Kate Gole
Map Author: Hamish West
Task ID: 6259
File Location: P:\Projects\gis_projects\RSIS\WB02900002\
File Name: appendix_2_aerial_photo1
Date: 20/04/2006

SOURCES
DoE acknowledges the following datasets and their Custodians in the production of this map:

Dataset Name - CUSTODIAN ACRONYM - Metadata	Date
Local Government Authorities DLI	08/07/2004
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Cadastre DLI	01/12/2005

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Aerial photo and assessment notes for Photo Section 1

Aerial Photo 1 Avon River – Aldersyde-Kweda Section (Survey date: 20.09.05)

No.	Section Ref.	L/holder	Riparian Zone Condition	FCA	Rating	Channel Condition
Start – 1	E. 514494 N. 6432342 Photos: 002, 003, 004	L- Handley R- Bell	• 20-80% cover – *Mel.* spp., Co, J, YG. • Senescent – *Mel.* spp. • Regeneration – *Mel.* sp. • Samphire at low-flow verge • In-stream logs/branches • Stream cover – poor • Important weeds – AVG, BG, SS	C1 C1-C1	19 Poor	• Minor meanders, • Minor anabranch at pt.1, no billabongs • Single channel, 15 m width, 60 cm depth • Significant bed-load sediment, sand slugs, no stabilised islands • Minimal bank erosion, no channel scour.
1-2	E. 514859 N. 6432064 Photos: 005	L- Handley R- Bell	• 20-80% cover –YG, FG, Co, J, Hp. • Senescent – mostly healthy • Regeneration – FG, Co. • Samphire/sedges verge • Minor in-stream logs/branches • Stream cover – poor • Important weeds – AVG, GG	C1 C1-C1	19 Poor	• Minor meanders • No anabranch, no billabongs • Single channel, 15 m width, 60 cm depth • Significant bed-load sediment, sand slugs, no stabilised islands • Localised bank erosion, no channel scour
2-3	E. 514852 N. 6431695 Photos: 006	L- Bell R- Bell	• 20-80% cover – W, FG, Co, J, • Senescent – mostly healthy • Regeneration – YG, Co. • Verge – Samphire • Minor in-stream logs/branches • Stream cover – poor • Important weeds – AVG, BG	C1 C1-C1	21 Moderate	• One meander, cliff face on LHS • No anabranch, no billabongs • Single channel, 15 m width, 50 cm depth • Significant bed-load sediment, sand slugs, initial stabilised island. • Minimal bank erosion, no channel scour
3-4	E. 514834 N. 6431302 Photos: 007	L- Bell R- Bell	• < 20% cover –W, SG, YG, FG, J, Si, Mr, Cs, SFS • Senescent – many senesc. • Regeneration – none noted • Verge – samphire/sedges • Minor in-stream logs/branches • Stream cover – poor • Important weeds – AVG, BG	C1 C1-C1	28 Moderate	• One meander • Significant anabranch, no billabongs • Single channel, 20 m width, 50cm depth • Limited bed-load sediment (stabilising), sand slugs, stabilised islands • Minimal bank erosion, no channel scour • RTS bank on LHS • Fresh seepage

Notes:

Dominant vegetation – YG = York gum (*Eucalyptus loxophleba*), FG = flooded gum (*Eucalyptus rudis*), SG = salmon gum (*Eucalyptus salmonophloia*), W = wandoo (*Eucalyptus wandoo*), Mr = swamp paperbark (*Melaleuca rhaphiophylla*), Mc = saltwater paperbark (*Melaleuca cuticularis*), Mu = broom bush (*Melaleuca uncinata*), Co = swamp sheoak (*Casuarina obesa*), J = jam (*Acacia acuminata*), Hp = needle bush (*Hakea preissii*), Hv = variable-leaved hakea *(Hakea varia)*, Si = spiked scholtzia (*Scholtzia involucrate*, Cp = lesser bottlebrush (*Calistemon phoeniceus*), PSS = pithy sour sedge, SFS = spiny flat sedge (*Cyperus gymnocaulus*), As = golden wreath wattle (*Acacia saligna*), Am = manna gum (*Acacia microbotrya*), Jk = shore rush (*Juncus kraussii*), Dr = blueberry lily (*Dianella revoluta*), Bp = acorn banksia (*Banksia prionotes)*, Adc = common woollybush (*Adenanthus cygnorum*), Jf = *Jacksonia furcellata/horrida*(?), SWC = saltwater couch (*Paspalum vaginatum*), BB = bluebush (*Mairiana brevifolia*), Et = creeping saltbush (*Enchylaena tomentosa*)

Notes (continued):

Weeds – AVG = annual veldt grass (*Ehrharta longiflora*), PVG = perennial veldt grass (*Ehrharta calycina*), BG = barley grass (*Hordeum leporinum*), SS = soursob (*Oxalis pes-caprae*), BC = bridal creeper (*Asparagus asparagoides*), GG = Guildford grass (*Ramulea rosea*), SR = spiny rush (*Juncus acutus*), R = radish (*Raphanus* spp.), P = puccinellia (*Puccinellia ciliata*), Ry = ryegrass (*Lolium* spp.), CT = Cape tulip (*Homeria* spp.), Wat = watsonia (*Watsonia* spp.), Cw = cape weed (*Arctotheca calendula*), Brm = brome grass (*Bromus* spp.)

Photo Section Description

Photo Section 1 commences at the confluence of the Upper Avon River and the outflow from the Yenyening Lakes at Qualandary Crossing. A gauging station) for stream flow and stream salinity measurement (operated by the Department of Environment is located just upstream of the confluence (photo 004). Floodwaters can cause backflow to either the lakes or the Upper Avon tributary.

The riparian zone is generally healthy although sparse and the under-story is dominated by annual weeds. A range of sedges/ rushes not found further upstream are located in this section.

The river flows north-west with one significant meander. There is one anabranch at pt. 1 and another between pt. 3 and pt. 4. This section has been subjected to the River Training Scheme (RTS). There is bank erosion of the RHS of the bend upstream from pt.3. There is considerable sediment bed load in the channel and unstable sand slugs.

Qualandry Road is located very close to the LHS of the river. Some road runoff to the river occurs.

Proposed Actions

A range of management actions that can be considered in this section include:

- Annual weed suppression by chemical control particularly to encourage regeneration of the sedges and several *Melaleuca* spp., (note – limited grazing at this location could damage the *Rhagodia* and *Enchalaena* species that occur in this section);
- Fencing on the LHS will need to be replaced after about five years;
- Opportunity for public access to the river with signage and recreational facilities (picnic etc.) between the road and the LHS of the river;
- The gauging station may be relocated upstream (to avoid flood backflows); and
- Road maintenance to ensure runoff does not cause sedimentation of the river.

Appendix 3 – Landholders in the Aldersyde-Kweda Section

Property owner	Lot numbers	Shire
David and Ingrid Bell	4235, 4340, 5257, 5663	Brookton/Beverley
Shane and Karen Bowron	6574, 14901, 14903, 14902, 15763	Brookton
Jack Brice	27559	Brookton
Jeff and Lear Edwards	Lot 2 on plan 7545	Pingelly
Don, Gary and Anne Eva	27497	Brookton
Lindsay, Jan and Michael Eva	4599, 4300, 5862, 5861	Brookton
George Hambley	5258, 5205, 4236, 4508, 4830, 5664	Brookton
David Gent	6517, 6316, 6517, Lot 2 on plan 15119	Corrigin
Ken Jamison and Ruth Owen	27562	Brookton
Kevin Lee	27569, 27568	Brookton
Colin and Brad Mills	5535, 4689, 6216, 4690, 4688, 5919, 6846, 9689	Brookton
Karen Mills	7189, 100, 101	Brookton
Kim Mills	8733, 6564, 6569, 6570, 12286, 12287, 10447, 10446, 6566, 6563, 6572, 6573, 6567	Brookton
Tom O'Meagher	5927, 5425, 6225, 5442, 10109	Brookton
John Ricketts	27560	Brookton
Albert Squires	7354, 6103, 6339	Pingelly
Kim Sturgess	13914	Brookton/Corrigin
Darrell and Suzanne Turner	6568, 6759, 14431	Brookton
Bevan and Denise Walters	6099, 7358, 5867, 5264, 5662, 6100, 7677, 9708, 9712, 9706, 6212	Brookton
Stuart and David Watson	7192, 7191, 6338, 6155, 27566, 27561, 27565, 27567, 27564, 27563, 27558, 27569, 7197	Brookton
Kevin White	5757, lot 2 in diag 25725, 6064, 18567, 13368, 16544, 18569	Pingelly

Appendix 4 - River Fence Condition

Avon River - Aldersyde-Kweda Section (Survey date: September 2005)

No.	LHS		RHS	
	Type	Condition	Type	Condition
1	Ringlock & barb wire	Moderate (5)	Ringlock	Good
2	Ringlock & barb wire	Moderate (5)	Ringlock	Good
3	Ringlock & barb wire	Moderate (5)	Ringlock	Good
4	Ringlock & barb wire	Poor	Ringlock	Good
5	Barb wire	Poor	Ringlock	Good
6	Barb change to barb	Poor change to good	Ringlock	Good
7	Barb wire	Moderate (5)	Ringlock	Good
8	Barb wire	Poor (replace)	Ringlock	Good
9	Barb wire	Moderate (5)	Ringlock	Good
10	Barb wire	Moderate (5)	Ringlock	Good
11	Barb wire	Moderate (5)	Ringlock	Good
12	Barb wire	Moderate (5)	Ringlock	Good
13	Barb wire	Moderate (5)	Ringlock	Good
14	Barb wire	Moderate (5)	Ringlock	Good
15	Strand fence	Poor (replace)	Ringlock	Good
16	Strand fence	Poor (replace)	Ringlock & barb wire	Good
17	Jam post fence	Poor	Ringlock & barb wire	Good
18	No fence	NA	Ringlock	Moderate
19	No fence, change to poor change to Ringlock	Poor, change to good	Ringlock	Moderate
20	Ringlock	Good	No fence	NA
21	Ringlock	Good	No fence	NA
22		Poor change to moderate (5)	No fence	NA
23	Strand fence	Poor (replace)	No fence	NA
24	Strand fence	poor	No fence	NA
25	Strand fence, change to ringlock	Poor, change to good	No fence, change to poor fence	Poor
26	Ringlock	Good	Poor fence	Poor
27	Ringlock	Good	Poor fence	Poor
28	Ringlock	Good	Poor fence, change to ringlock	Poor change to good
29	Ringlock	Good	Ringlock	Good
30	Ringlock	Moderate (sand build up)	Ringlock	Good
31	Ringlock	Good	Ringlock & barb	Good
32	Ringlock	Good	Ringlock	Good
33	Ringlock	Good	Ringlock	Good
34	Ringlock	Good	Ringlock	Good
35	Poor fence	Poor	Moderate fence	Moderate (10)
36	Moderate fence	Moderate (10)	Moderate fence	Moderate (10)

No.	LHS		RHS	
	Type	Condition	Type	Condition
37	Moderate fence	Moderate (10) needs clearing	Moderate fence change to ringlock	Moderate change to good
38	Moderate fence	Moderate (10)	Ringlock	Good
39	Ringlock change to moderate fence	Good change to moderate	Ringlock	Good
40	Moderate fence change to ringlock	Moderate change to good	Ringlock	Good
41	Ringlock	Good	Ringlock	Good
42	Ringlock	Good	Ringlock	Good
43	Ringlock	Good	Ringlock	Good
44	Ringlock	Good	Ringlock	Good
45	Ringlock	Good	Ringlock	Good
46	Ringlock	Good	Poor fence	Poor
47	Ringlock	Good	Poor fence change to Ringlock	Poor change to Good
48	Ringlock	Good	Ringlock	Good
49	Ringlock	Good	Ringlock	Good
50	Ringlock	Good	Ringlock	Good
51	Ringlock	Good	Ringlock	Good
52	Ringlock	Good	Ringlock	Good
53	Ringlock & barb,wooden	Good	Ringlock, steel	Good
54	Ringlock & barb,wooden	Good		
55	Ringlock & barb,wooden	Moderate	Ringlock, steel	Good
56	Ringlock, steel	Good	Ringlock, steel	Good
57	Ringlock, steel	Good	Ringlock, steel	Good
58	Ringlock, steel	Good	Ringlock, steel	Good
59	Ringlock, steel	Good	Ringlock, steel	Good
60	Wood, strand fence	Poor	Ringlock, steel	Good
61	Wood, strand fence	Poor	Ringlock, steel	Good
62	Ringlock, steel	Good	Ringlock & barb, steel	Moderate (10)
63	Ringlock, steel	Good	Ringlock & barb, steel	Moderate (10)
64	Wire	Poor	Barb wire	Moderate (10)
65	Wire	Moderate (10)	Wire	Moderate (10)
66	Ringlock	Moderate (10)	Wire	Moderate (5)
67	Ringlock	Poor	Ringlock	Moderate (10)
68	Ringlock, steel	Good	Ringlock	Good
69	Ringlock	Good	Ringlock	Moderate
70	Ringlock	Good	Ringlock	Good
71	Ringlock, steel	Good		
72	Ringlock, steel	Good		
73	Ringlock & barb,wooden	Moderate(10)	Ringlock, steel	Moderate (5)
74	Ringlock, steel	Moderate(10)	Ringlock, wood	Moderate (5)
75	Ringlock, wood	Moderate(10)	Ringlock, wood	Moderate (5)
76	Ringlock, steel	Moderate (10)	Ringlock, wood	Moderate (5)
77	Ringlock	Good	Ringlock, wood	Moderate (10)

No.	LHS		RHS	
	Type	Condition	Type	Condition
78	Ringlock	Good	Ringlock	Moderate (5)
79	Ringlock	Good	Ringlock	Moderate (5)
80	Ringlock	Good	Moderate fencing	Moderate (5)
81	Poor fencing	Poor	Moderate fencing	Moderate (5)
82	Ringlock	Good	Ringlock	Poor
83	Ringlock	Good	Ringlock	Poor
84	Ringlock	Good	Ringlock	Poor
85	Ringlock	Good	Ringlock	Poor
86	Ringlock, wood	Moderate(5)	Ringlock	Poor
87				
88	Ringlock	Good		
89	Ringlock change to ringlock and wood	Good change to poor		
90				
91				
92			Ringlock, steel	Moderate (5)
93	Ringlock, wood	Moderate (5)	Ringlock, wood	Moderate (5)
94	Ringlock, wood	Moderate (5)	Ringlock, wood	Moderate (5)
95	Ringlock, wood	Moderate (5)	Ringlock, steel	Moderate (10)
96	Ringlock, wood	Moderate (5)	Ringlock, wood	Moderate (5)
97	Ringlock, wood	Moderate (5)		
98	Ringlock	Moderate (10)	Ringlock	Moderate (10)
99	Ringlock	Moderate (10)	Ringlock, steel	Moderate (10)
100	Ringlock	Moderate (10)		
101	Ringlock, steel	Moderate (10)	Ringlock, steel	Moderate (10)
102	Ringlock, steel	Moderate (10)	Ringlock, steel	Moderate (10)
103	Ringlock	Good	Ringlock	Moderate (10)
104	Ringlock	Good	Ringlock	Moderate (10)
105	Ringlock	Good	Ringlock	Moderate (10)
106	Ringlock	Good		
107	Ringlock	Good		
108	Ringlock	Good		
109	Ringlock	Good		
110	Ringlock	Moderate (10)	Ringlock	Moderate (10)
111	Ringlock	Moderate (10)	Ringlock	Moderate (10)
112	Ringlock, steel	Good		
113	Ringlock	Good	Ringlock	Good
114	Ringlock	Good		
115	Ringlock	Moderate (10)		
116	Ringlock	Moderate (10)	Ringlock	Poor
117	Ringlock	Moderate (10)	No fence	NA
118	No fence	NA	No fence	NA
119	No fence	NA	No fence	NA

Appendix 5 – Bird Species Richness

Bird species observed during the 2005 river survey

Note: Species with (?) have uncertain identification due to limited field observation.

Common name	*Scientific name*
Australasian Grebe	*Tachybaptus novaellandiae*
Australasian Shelduck	*Tadorna tadornoidies*
Australian Magpie	*Gymnorhina tibicen*
Australian Magpie-Lark	*Grallina cyanoleuca*
Australian Owlet-nightjar	*Aegotheles cristatus*
Australian Raven/ Little Crow (?)	*Corvus coronoides*
Australian Ringneck	*Barnardius zonarius race zonarius*
Australian Wood Duck	*Chenonetta jubata*
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
Black-faced Woodswallow	*Artamus cinereus*
Black-winged Stilt	*Himantopus himantopus*
Brown Goshawk	*Accipiter fasciatus*
Brown Headed honey-eater	*Melithreptus brevirostris*
Brown Honey-eater	*Lichmera indisticncta*
Brown Quail (?)	*Coturnix ypsilophora*
Brown Song-lark	*Cincloranphus mathewsi*
Chestnut Teal	*Anas castanea*
Corella	*Cacatua spp*
Crested Pigeon	*Ocyphaps lophotes*
Dotterel (?)	
Elegant Parrot	*Neophema elegans*
Eurasian Coot	*Fulica atra*
Fan-tailed Cuckoo	*Cacomantis castaneiventris*
Galah	*Eolophus roseicapilla*
Grey Butcherbird	*Cracticus torquatus*
Grey Fantail	*Rhipidura fuliginosa*
Grey Shrike-thrush	*Colluricincla harmonica*
Grey Teal	*Anas gracilis*
Hoary-headed Grebe	*Poliocephalus poliocephalus*

Horsfield's Bronze-Cuckoo	*Chalcites basalis*
Inland (Broad-tailed) Thornbill	*Acanthiza pursilla*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Little Eagle	*Hieraaetus morphnoides*
Musk Duck	*Biziura lobata*
Nankeen (Australian) Kestrel	*Falco cenchroides*
Pacific Black Duck	*Anas superciliosa*
Rainbow Bee-eater	*Merops ornatus*
Reagent Parrot	*Polytelis anthopelus*
Red Wattle-bird	*Anthochaera carunculata*
Red-capped Robin	*Petroica goodenovii*
Rufous Treecreeper	*Climacteris picumnus*
Rufous Whistler	*Pachycephala rufiventris*
Sacred Kingfisher	*Todiramphus sanctus*
Singing Honey-eater	*Lichenostomus virescens*
Southern Boobook Owl	*Ninox boobook*
Striated Pardalote	*Pardalotus rubricatus*
Tree Martin	*Petrochelidon nigricans*
Varied Sittella	*Daphoenositta chrysoptera*
Wedge-tailed Eagle	*Aquila audax*
Weebill	*Smicronis brevirostris race occidentalis*
Welcome Swallow	*Hirundo neoxena*
Western Gerygone	*Gerygone fusca*
White-browed Babbler	*Pomatostomus superciliosus*
White-faced Heron	*Egretta novaehollandiae*
White-winged Triller	*Lalage tricolor*
Willie Wagtail	*Rhipidura leucophrys*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*
Yellow-throated Miner	*Manorina flavigula*

Aldersyde-Kweda Section – Bird Species Richness

Site	R	Site	R	Site	R
53-54	6 (r, f)	75-76	5	97-98	6
54-55	8	76-77	3	98-99	6
55-56	8	77-78	8	99-100	9
56-57	8 (r, f)	78-79	3	100-101	6 (f)
57-58	10	79-80	7 (r, f)	101-102	4
58-59	2	80-81	2	102-103	2
59-60	4 (r, f)	81-82	2	103-104	3
60-61	6	82-83	5	104-105	6
61-62	6	83-84	5	105-106	8
62-63	5	84-85	3	106-107	8
63-64	4	85-86	2	107-108	0
64-65	4	86-87	4	108-109	5
65-66	12	87-88	3	109-110	8
66-67	2	88-89	4	110-111	4
67-68	6	89-90	4	111-112	5
68-69	2	90-91	9	112-113	4
69-70	3	91-92	2	113-114	8 (r)
70-71	5	92-93	0	114-115	8
71-72	6	93-94	2	115-116	11
72-73	4 (r)	94-95	0	116-117	6
73-74	8	95-96	4	117-118	6
74-75	6	96-97	3	118-119	10

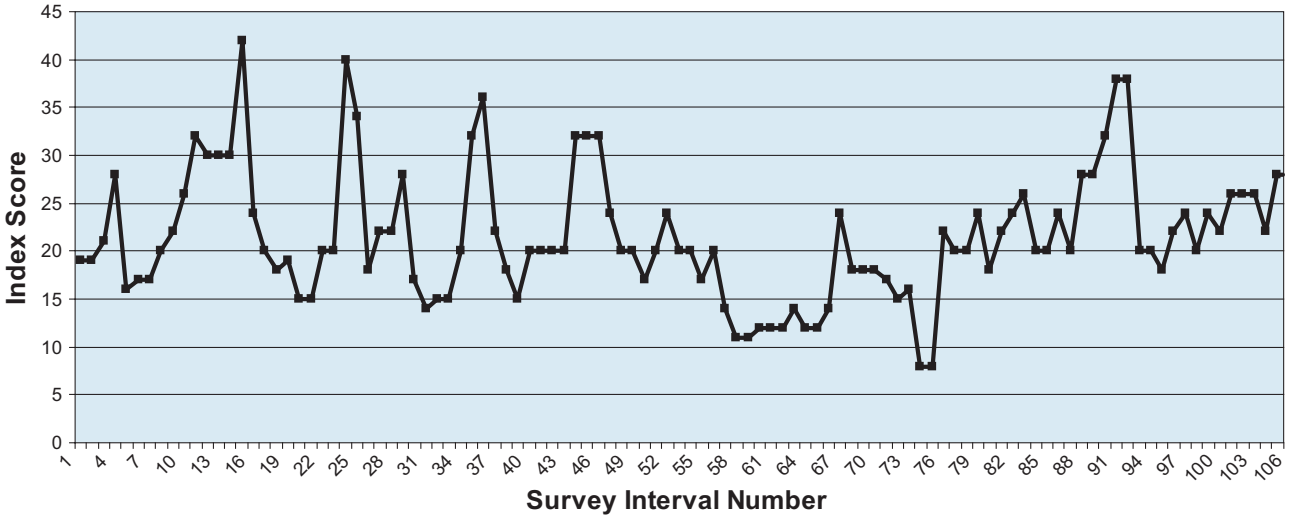
R = Bird Species Richness (number of species observed on the day of survey)

r = Rabbits

f = Foxes

Appendix 6 – 'River Health Index' for the Aldersyde-Kweda Section of the Avon River

River Health Index



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.....

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