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

# River Recovery Plan for the Dale River

## Incorporating foreshore and channel assessment

River Recovery Plan Series

REPORT NO. RRP 10
APRIL 2006

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AVON CATCHMENT COUNCIL

Natural Heritage Trust
*Helping Communities Helping Australia*

Government of Western Australia

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Department of Water

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### We welcome your feedback

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Cover Photograph: Dale River (taken by Kate Gole)

# Foreword

The Dale River is distinctive, most notably because it is one of the last relatively fresh waterways in the Western Australian Wheatbelt. After more than 150 years of farming and pastoral activity in the catchment, the Dale remains mostly a beautiful and interesting river.

However, the Dale is degrading. Many of the river pools, used historically for recreation and vital refuges for wildlife, are filling with sediment. The remaining riparian vegetation is generally in poor health and infested with weeds. There is a need for extensive revegetation and for improved vegetation management and soil conservation along the river and along all the major tributaries.

Problems in the wider catchment such as salinity, pollution, loss of riparian and aquatic ecosystems, fire risk, weeds and feral animals all impact on the river. Additionally, there are concerns from river neighbours about the risk of flooding due to the river channel and pools being blocked with sediment.

Hence there is a need to develop a new, shared, positive and achievable vision for the river and to formulate actions to recover the health of the Dale River. These aims are captured in this River Recovery Plan for the Dale River.

This River Recovery Plan and foreshore and channel assessment, funded by the Natural Heritage Trust and Department of Water through the Avon Catchment Council, forms part of the Avon River Management Programme. It is unique in that it is the first River Recovery Plan to be written for a tributary of the Avon River and the first to incorporate a foreshore and channel assessment.

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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 |
| DPI | Department of Planning and Industry |
| FESA | Fire and Emergency Services Authority of Western Australia |
| WAPC | Western Australian Planning Commission |

# 1. Introduction

## Recovering the Dale River

This River Recovery Plan and foreshore and channel assessment deals with the Dale River, the last relatively fresh river in the central agricultural area of Western Australia. It is one of a series being developed by the Department of Water (DoW) and Avon Waterways Committee (AWC) with the assistance of local communities, as part of the Avon River Management Programme. The aim of the Programme is to restore and manage the natural functions of the Avon River system for the long-term benefit of the community.

Previous River Recovery Plans for this region have focussed on the Avon River. This is the first of these plans that looks at an entire tributary, from its upper catchment to its mouth and the first to include a foreshore and channel assessment. The plan is based upon information about the river, its tributaries and catchment derived from community input and the foreshore and channel assessment conducted by DoE.

## Location of the Dale River catchment

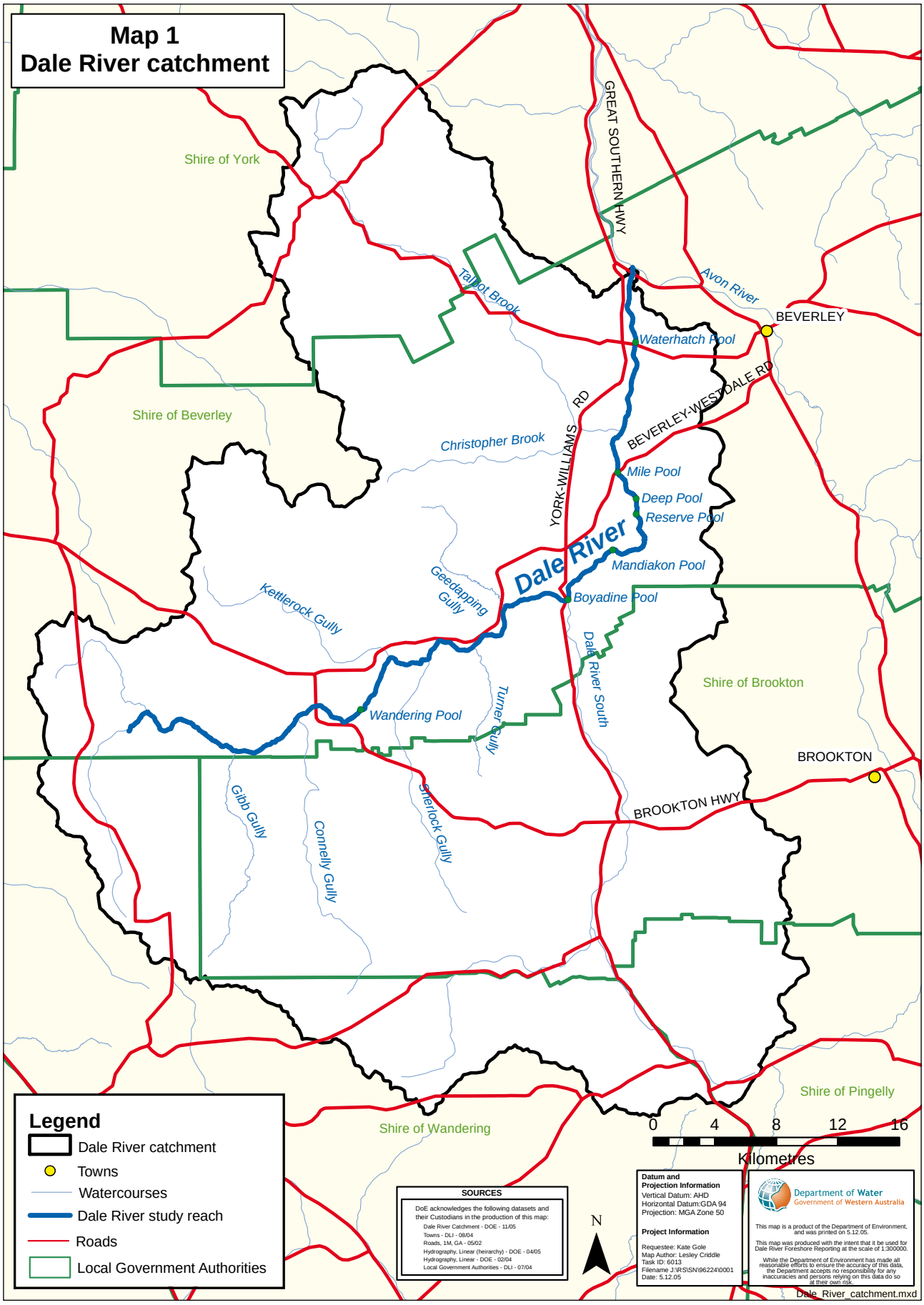
Before looking at the current environmental condition of the Dale River and how it needs to be managed to improve its health, it is important first to understand the unique character of the Dale River.

The Avon River Basin is a major Australian river system that is dominant in the central Wheatbelt in the south west of Western Australia. It has a catchment area of 120 000 km$^2$, which makes it larger than Tasmania, and extends north of Wongan Hills, south of Lake Grace and east of Southern Cross. The Avon River Basin is also significant as it drains into the Swan-Canning river system, which is central to the character of the State's capital, Perth. The Dale River is a significant tributary of the Avon River. Figure 1 shows the location of the Dale River Catchment within the wider catchment.

The Dale River catchment covers approximately 1367 km$^2$ and is located to the east of the Darling Range and west of the town of Beverley. The main channel of the Dale River flows through the Shire of Beverley with tributaries extending into the Shires of York, Brookton, Pingelly and Wandering (refer to Map 1).


*Figure 1. Location of the Dale River Catchment*

The Dale has its headwaters in the high rainfall zone of the Darling Range and as it flows east it is joined by Gibb Gully, Connelly Gully, Kettlerock Gully, Sherlock




*Map 1. Dale River catchment*

Gully, Turner Gully, Geedapping Gully, Dale River South Branch, Talbot Brook and numerous minor creeklines before entering the Avon River approximately 12 km downstream of the town of Beverley.

## The distinctive character of the Dale River

The Dale River is especially notable for two things:

1. It is the only east-ward flowing river in the southern agricultural region of Western Australia; and
2. It is the only waterway that provides a vegetation corridor between the forest country to the west and the Avon River, which mostly flows through cleared agricultural regions.

The Dale River has a number of other important features including:

- The confluence of the Dale with the Avon River, 12 km north-west of Beverley. This is only 11.5 km upstream of Gwambygine Pool, one of the last great pools on the Avon River which is still in excellent health, partly as a result of the water quality entering the Avon from the Dale;
- The confluence of the Dale and the Talbot Brook. Talbot Brook drains a major sub-catchment to the west of the main channel, an area that generates high levels of salinity and is thus critical to the health of the Dale and Avon rivers;
- Twenty-five named river pools, linked by channel sections, some of which are substantial pools;
- The confluence with the Dale South Branch, which drains a large catchment to the south in the shires of Pingelly and Wandering (an area not covered in this plan);
- A number of other major tributaries including Geedapping Gully, Kettlerock Gully, Connelly Gully and Sherlock Gully, plus a myriad of smaller tributaries.
- Christopher Brook which flows into the Talbot Brook just above the junction with the Dale and which is a relatively freshwater stream;
- Sites of importance to Noongyar people;
- A large area of deep sandy soils and swamp lands west of Kokeby, which may be an important source of relatively fresh groundwater moving into the Dale; and
- The head of the catchment, which lies within crown land (State forest and conservation reserve) and adjoins the watersheds of west-ward flowing streams which drain into the Canning and Helena Rivers.

After more than 150 years of farming and pastoral activity in the catchment of the Dale, it remains mostly a beautiful and interesting river. Unlike the Avon River, the Dale was never subjected to ‘river training’

*Table 1. Average yearly climatic factors for regional locations in proximity to Dale River catchment (Australian Bureau of Meteorology, 2005)*

| Climatic factor | Beverley | Brookton | Wandering |
|---|---|---|---|
| Rainfall (mm) | 420.4 | 458.2 | 613.7 |
| Maximum temperature (°C) | 25.2 | 23.8 | 23.1 |
| Minimum temperature (°C) | 10.2 | 9.4 | 8.4 |
| Wind speed (km/hr) | 13.3 | 15.3 | 13.4 |

with bulldozers, and the basic structure of pools linked by braided channels is still in place. Furthermore, the Dale is still a relatively fresh source of water into the Avon.

However, the Dale is degrading. Many of the river pools have been filled, or are filling with sediment. The banks are eroding along almost the whole length of the river and this is contributing to sedimentation and in-filling of pools. The thin strip of riparian vegetation is generally in poor health or infested with weeds. There is a need for extensive revegetation and for improved vegetation management and soil conservation along the river and along all the major tributaries. There are wider problems in the catchment, including salinity, pollution, loss of riparian and aquatic ecosystems, un-managed fire risk, weeds and feral animals. Additionally, there are concerns from some river neighbours about the risk of flooding in the event of heavy winter rainfall, due to the river channel and pools being blocked with sediment.

On a positive note, there is significant Shire and local community interest in returning the Dale River to its former health and beauty, as demonstrated by community input to this River Recovery Plan.

## Climate

The Dale River catchment has a Mediterranean climate with hot, dry summers and cool, wet winters (refer to Table 1). Average annual rainfall decreases from the western edge of the catchment boundary to the east from approximately 700 mm in the Darling Range to approximately 400 to 450 mm towards Beverley (Australian Bureau of Meteorology, 2005).

## Geomorphology and soils

The Dale River catchment falls within the Zone of Rejuvenated Drainage, defined by the Meckering Line (117°E longitude) to the east and the Darling Range to the west. This physiogeographical region is characterised by greater dissection than the Zone of Ancient Drainage to the east. The landscape pattern is typically small, flat-topped hills capped by laterite separated by mildly dissected valleys through which seasonal rivers and creeklines flow (Lantzke and Fulton, undated; McArthur, 1991).

There are several suites of soils within the Dale River catchment (Map 2), each associated with a specific location in the landscape. These include the:

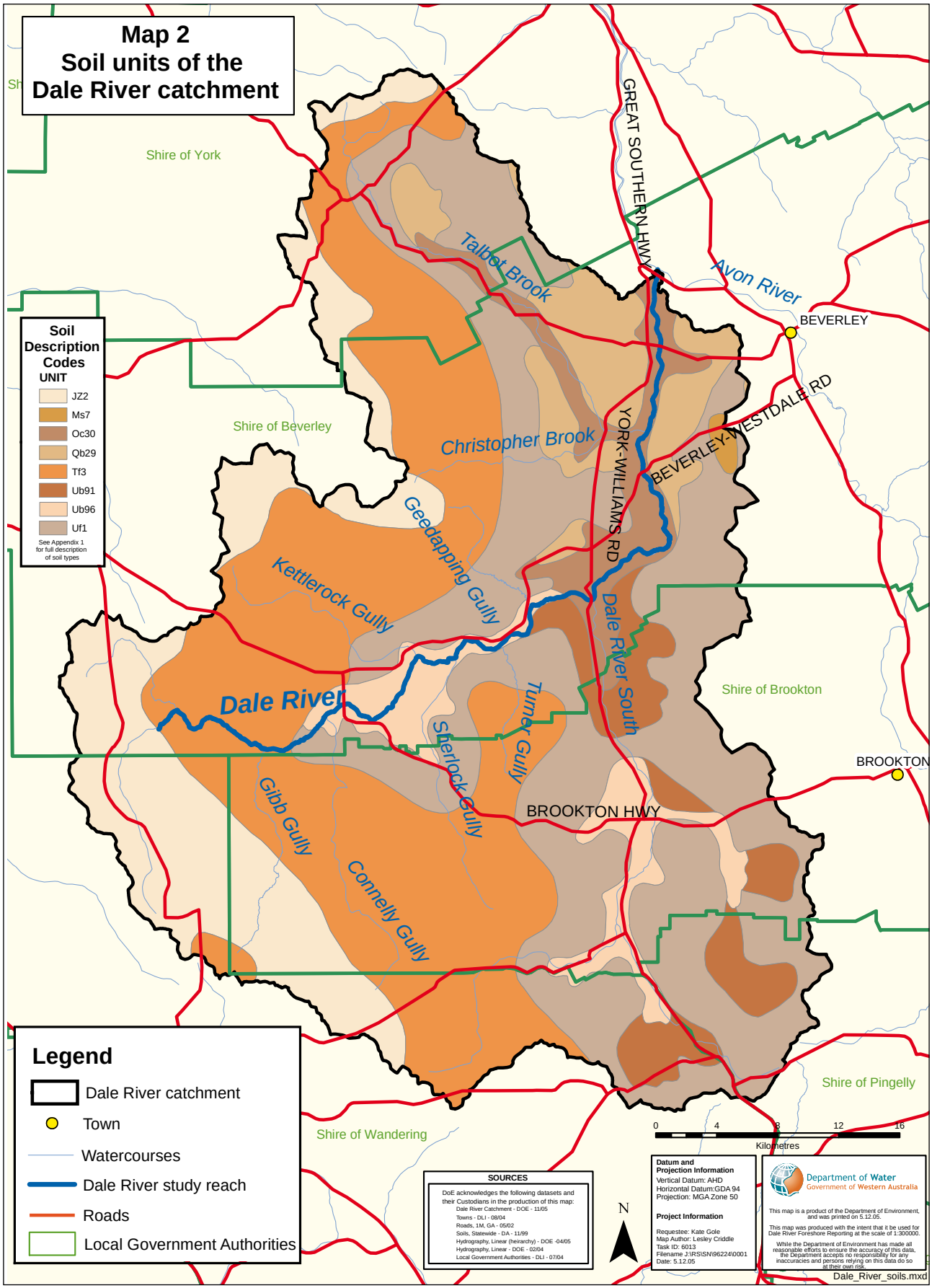
- Sandplain soils, including Ms7 and Uf1, formed from the remnants of the ancient lateritic profile;
- Hillslope soils, including JZ2, Tf3, Qb29, and Ub91, formed from the dissection of the lateritic profile; and
- Valley floor soils, including Oc30 and Ub96, formed from deposition of sediments transported by rivers (Lantzke and Fulton, undated; McArthur, 1991).

Appendix 1 provides a description of each soil unit.

## Groundwater

There is very little groundwater information for the Dale River catchment, although several studies have investigated groundwater processes in some sub-catchments.

Water Direct Ltd undertook an assessment of groundwater resources in the Beverley and Brookton shires. The study identified five basic aquifer types:




*Map 2. Soil units of the Dale River catchment*

- Fractured rock aquifers which yield fresh to saline water depending on the location in the landscape;
- Superficial alluvial aquifers which contain stock-quality water in small sand lenses between clay layers in drainage lines;
- Fresh to brackish springs flowing from sand mounds;
- A palaeochannel aquifer near Maitland Swamp, formed from an ancient drainage line, which yields fresh to brackish water; and
- A palaeobasin to the south of Maitland Swamp, which yields fresh to marginal water (Water Direct Ltd, 2002).

The Department of Agriculture WA (DAWA) undertook a rapid catchment assessment in the Kettlerock-Kokedin sub-catchment and described groundwater resources in the catchment as marginal to brackish with most groundwater suitable for stock watering purposes. Both local and intermediate groundwater systems were identified. The local groundwater system is comprised of fractured rock, unconfined (perched) and semi-confined aquifers (Department of Agriculture WA, 2002).

Fractured rock aquifers are fractures or faults in the bedrock that contain water whereas superficial aquifers are unconfined watertable systems that occur in the actively weathered zone between the bedrock and saprolite. Semi-confined aquifers commonly occur on a regional scale. An intermediate flow system is present as a deeper aquifer that extends over most of the catchment (Department of Agriculture WA, 2002).

Several studies have investigated groundwater processes in the West Dale sub-catchment. Lewis and McConnell investigated recharge mechanisms in relation to salinity and found that:

- Seasonal groundwater rise in the West Dale catchment is relatively large, even in dry years;
- There is a quick recharge response to rainfall across the landscape;
- Groundwater rise in valley floors is a result of recharge higher in the landscape rather than in-situ recharge;
- The long-term trend is an increase in the discharge area rather than an overall increase in the groundwater level as drainage rates are similar to recharge rates; and
- Salts tend to accumulate on the valley floors, with groundwater conductivities tending to be greater than 1000 mS/m (Lewis and McConnell, 1998).

The consequence of these findings in terms of groundwater management is that in order to reduce groundwater recharge a management system is needed that incorporates plants with a range or rooting depths and active growing seasons over broad areas of the catchment (Lewis and McConnell, 1998).

A further study in the West Dale catchment found that salinity manifested in the catchment in a number of ways including:

- In small valleys and drainage lines;
- On broad valley floors, due to discharge in the lowest part of the landscape;
- As seeps on valley floors due to shallow bedrock;
- As seepage on hillslopes due to bedrock highs;
- Associated with fractured rock aquifers; and
- Associated with dams, which act as barriers to groundwater flow (Graeffe, 1998).

## Water quality snapshots

There have been two water quality snapshots undertaken in the Dale River catchment. The most recent, which collected data on salinity, turbidity, pH and temperature, was conducted on 17 June 2005 by DoE to give an indication of water quality at eighteen sites on the main channel and tributaries. The results of this study are set out in Appendix 2. This was a one-off study and only gives an indication of the water quality for the day the readings were taken. The snapshot was conducted on a day when the stage height (river level) was rising, the discharge peaked at 12.93 $m^3$/sec and 9.2 mm of rainfall was recorded. This data were recorded at the DoE gauging station 615027 at Waterhatch Bridge.

The pH across the eighteen sampling sites was neutral and water temperature ranged between 10-12°C. For most sites the turbidity (measured using a Morgan Turbidity tube) indicated water with a good clarity (< 25 NTU) with the exception of Talbot Brook which, with a reading of 40-50 NTU, was relatively turbid. Most of the sites were classified as brackish, although three sites including Christopher Brook and the Dale River on Great Southern Highway and Waterhatch Road, were marginal.

Six sites across the Dale River catchment were sampled three times during June, July and August 1997. The median water quality results are presented in Table 2 and the full results are set out in Appendix 3.

This study showed that the Dale and its tributaries had lower concentrations of salt and nitrogen than the Avon River and comparable concentrations of sediment and phosphorus. Salinity, Total Nitrogen, Total Phosphorus and Total Suspended Solids were similar across the Dale River catchment with the exception of Christopher Brook which was significantly less saline than other sampling sites (Water and Rivers Commission, 1997c).

## Longer term trends

The average stream salinity (over the period 1993 to 2002) at DoW gauging station on Dale River South Branch was 3700 mg $L^{-1}$ TDS, which is classed as moderately saline (Mayer et al, 2005).

Longer term data collected at the DoE gauging stations on the Dale River South Branch, which joins the Dale River at Boyadine, and the main channel at Waterhatch Bridge indicates that flow volumes and salinity vary seasonally and from year to year. Generally, salinity increases with decreasing flow in the drier months of the year as the salt is concentrated in the relatively smaller

*Table 2. Median water quality results for Dale River catchment sampling sites (Source: Water and Rivers Commission, 1997c)*

| Site number | Waterway | Total Phosphorus (mg $L^{-1}$) | Total Nitrogen (mg $L^{-1}$) | Electrical Conductivity (mS/m) | Salinity Classification | Total Suspended Solids (mg $L^{-1}$) |
|---|---|---|---|---|---|---|
| AS51 | Dale River | 0.017 | 0.58 | 1100 | Low saline | 5 |
| AS52 | Talbot Brook | 0.017 | 0.64 | 1200 | Low saline | 5.5 |
| AS53 | Christopher Brook | 0.016 | 0.48 | 850 | Brackish | 4 |
| AS54 | Dale River | 0.013 | 0.56 | 1500 | Low saline | 6 |
| AS55 | Dale River | 0.029 | 0.74 | 1300 | Low saline | 4 |
| AS56 | Dale River South | 0.011 | 0.49 | 1300 | Low saline | 5 |

volume of water and decreases with the increased flow in wetter months as the larger volume of fresh water entering the river from the catchment dilutes the salts (Figures 2 and 3).

## Land use and tenure

Most of the Dale River catchment is freehold land used mainly for cropping and sheep and cattle grazing however, some land is used for rural residential and hobby farming.

There are large areas of State forest in the west of the catchment and Crown Reserves scattered throughout. These reserves include land set aside for flora and fauna conservation and the Avondale Research Farm, a historical farm and agricultural research station near Beverley. The land tenure of the Dale River riparian zone varies but most is privately owned.

Land use in the catchment is changing. Since the early 1990s some properties adjacent to the river in the middle and upper sections of the catchment have been subdivided and there has been a growth of 'hobby farming'. This has the potential to introduce 'urban' issues, such as buildings on the flood plain, disposal of sewage and rubbish, and bushfires. Another land use change has been the development on some properties of commercial tree plantations, including maritime pine and sandalwood. Land use changes can have positive impacts, providing opportunities for improving the river environment.

The decade of the 1990s also saw a new emphasis on Landcare in the Dale River catchment. On a number of properties this has resulted in fencing of waterways, tree planting/revegetation, flora and fauna conservation, and the adoption of conservation practices aimed at minimising soil erosion and salinity. This work has been undertaken voluntarily by landowners, in some cases supported by community groups, the DoW and the DAWA.

As a consequence of increased demands for land use change in areas close to the Metropolitan area, the Western Australian Planning Commission (WAPC) published the Avon Arc Sub-Regional Strategy in 2001. This strategy provides guidance to local authorities in the area for sound land use planning that accounts for environmental needs, as well as for social and economic objectives. The Dale catchment falls within the area covered by this strategy.

## Other studies in the Dale River catchment

In addition to the catchment and hydrogeological studies already discussed, a number of other studies have been conducted within the Dale River catchment.

A foreshore and channel assessment was completed for the Talbot Brook catchment in 2001 using the same methodology as the Dale River foreshore and channel assessment (see Chapter 3 for the methodology). The main findings from the study were:

- Generally Talbot Brook was rated as a C-grade system, indicating that the structure of the riparian vegetation consists mainly of trees over weeds or pasture resulting in localised areas of bank erosion;
- Erosion and sedimentation were significant concerns;
- Sixty-eight per cent of the brook was fenced on one or both sides and was stock proof, with only 3% of fenced sections in poor condition;
- Seventy-four per cent of the brook had a poor overall environmental stream health rating;

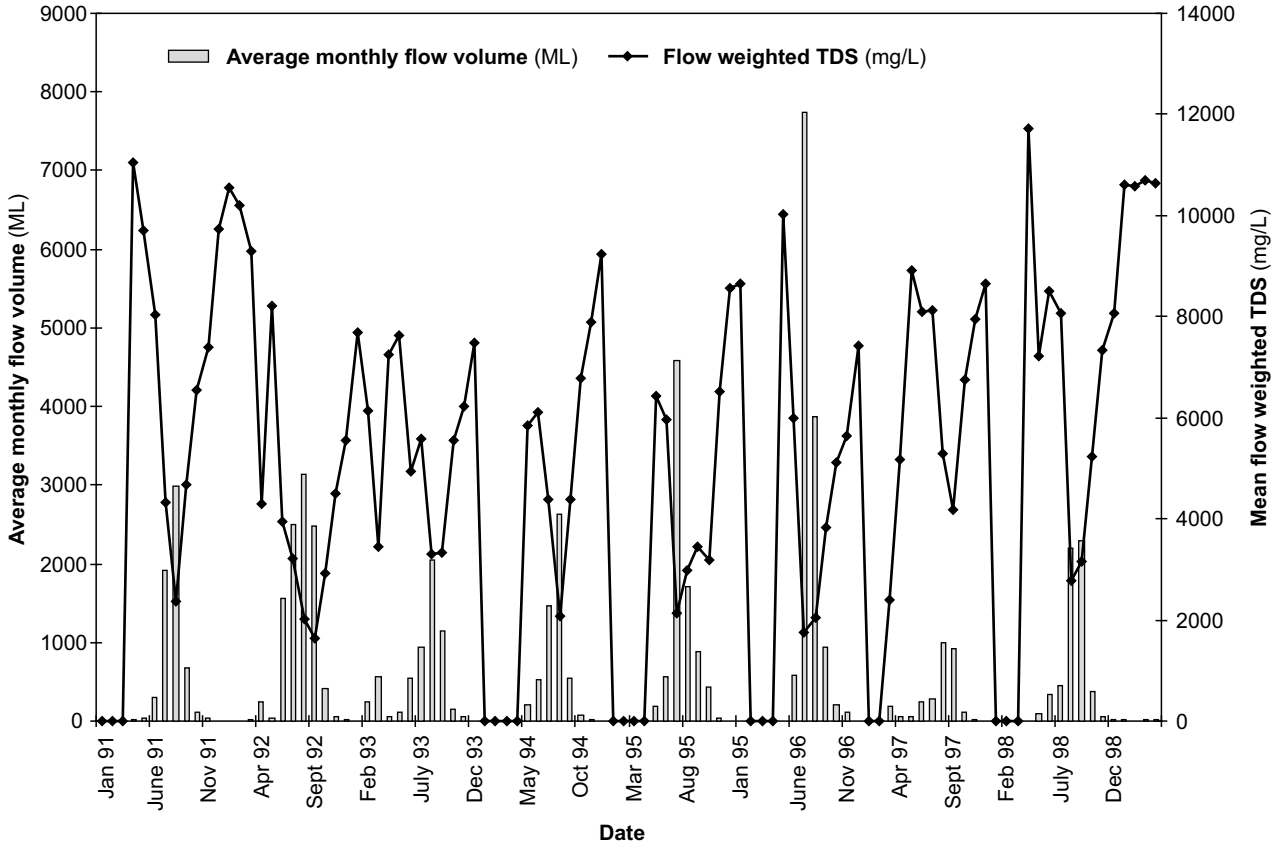



*Figure 2. Average monthly flow and salinity for the Dale River at Waterhatch Bridge*

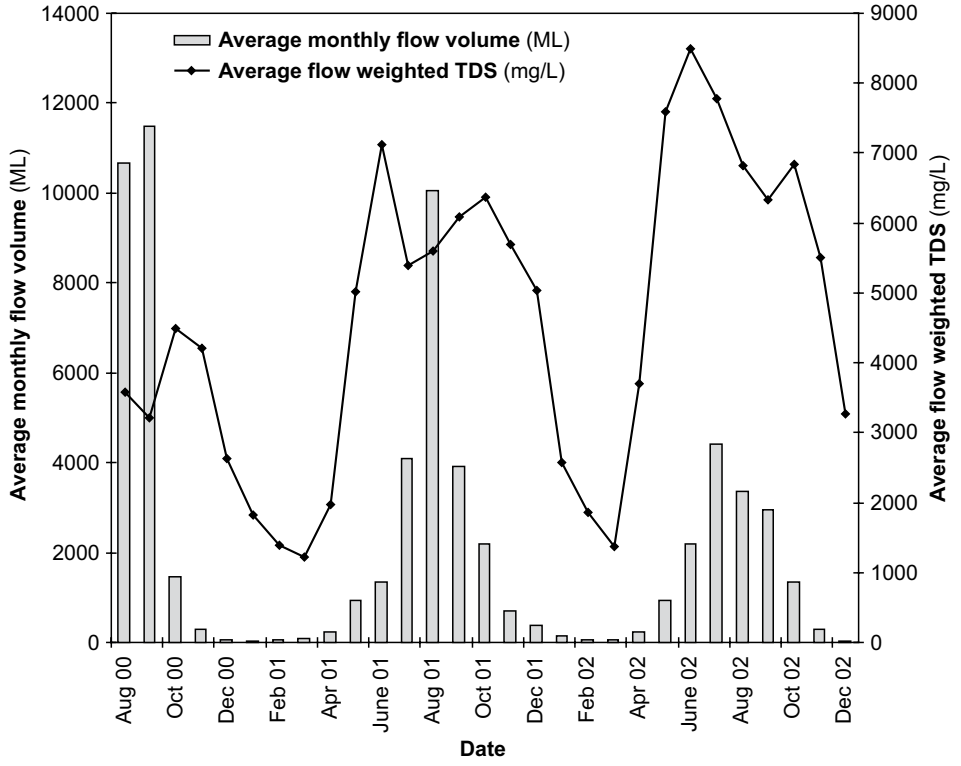



*Figure 3. Average monthly flow and salinity for the Dale River South Branch at Brookton Highway*

- The main disturbance factors were weed invasion, feral animals, vehicle and stock access, pollution from animal manure and crop spraying, vehicle and stock crossings and rubbish;
- The management issues most in need of action were weed control, stock access, salinity and fire risk; and
- The most common management strategies employed by landholders were fencing, surface water management, revegetation, firebreaks and weed control (Water and Rivers Commission, 2002a).

A Rivercare workshop for local landholders was conducted in July 2004 by the Water and Rivers Commission, Talbot Brook Land Management Association and the York Land Conservation District Committee. The workshop was held on Boyanning Creek, a tributary of Talbot Brook, and covered foreshore assessment, river restoration techniques, water quality monitoring, riparian revegetation, water quality monitoring and integrated catchment management.

DAWA undertook a rapid catchment appraisal (RCA) of the Kettlerock-Kokendin catchment in 2001. The main findings were:

- Salinity affected 2% of the catchment area with a further 18% at risk if existing management strategies continued;
- Remnant vegetation covered 32% of the catchment area with 10% at risk from shallow water tables;
- Sixty per cent of remnant vegetation was degraded or very degraded; and
- Seventy per cent of soils in the catchment were susceptible to near-surface acidification, 57% to subsoil compaction, 55% to wind erosion and 53% to water repellence (Department of Agriculture WA, 2002).

The West Dale Landcare Group formed in 1989 to address the degradation of the local landscape through cooperative planning and integrated work programs across farm boundaries. In 1990 the group attracted sponsorship from Alcoa of Australia Limited and formed a three-way partnership with DAWA and became a demonstration group for other catchment groups in the State (Landcare Vision, 2005).

Some of the group's achievements between 1989 and 1998 include planting 224 000 trees, developing 86 kilometres of shelterbelts, erecting 86 kilometres of fencing, installing 161 piezometers and retaining 2068 hectares of remnant vegetation (Landcare Vision, 2005).

Since 1995 the York River Conservation Society has been monitoring physical and chemical parameters, including conductivity, pH, temperature and turbidity, at a number of local sites, including Mile Pool and the main channel of the Dale upstream of the Great Southern Highway bridge.

The Beverley Naturalists' Club undertook flora surveys in the Beverley Shire in 2005, including two areas in the Dale River catchment. The combined flora list from these sites has been included in Appendix 10.

# 2. The River Recovery Plan process

## The need for a River Recovery Plan for the Dale

The lands that encompass the Dale River and its tributaries were once wholly covered by forest and woodlands and were home to families of Noongyar people. It is thought that they occupied these lands for over 40 000 years. During this time they developed a sustainable life style based on hunting, gathering, fishing and maintenance of woodland and savannah ecosystems through regular and controlled use of fire. The river was a source of food and was an important spiritual resource to Aboriginal people.

Following the 'discovery' of the Dale River by Ensign Dale in 1830 and his report of a beautiful landscape with rich soils, settlement quickly followed. At that time, and through the early years of European settlement, the Dale River was fresh, and teemed with wildlife.

The river channels were braided, with many small channels inter-weaving between islands carrying thick stands of flooded gum (*Eucalyptus rudis*), swamp sheoak (*Casuarina obesa*) and swamp paperbark (*Melaleuca rhaphiophylla*) and there were numerous deep, shady pools, anabranches and billabongs. The uplands beyond the floodplain of the river were dominated by York gum (*Eucalyptus loxophelba*), wandoo (*Eucalyptus wandoo*), and marri (*Corymbia calophylla*) with powderbark wandoo (*Eucalyptus accedens*) on the lateritic breakaways in the upper reaches of the river and of the Talbot Brook.

European settlement of the Avon Valley and the Dale districts commenced in the early 1830s. Early settlers focussed on wool growing, with flocks depastured in the bush and watered in the river and along the fresh water streams which flowed into it. By the end of the nineteenth century, extensive areas had been cleared and pastured or were being used for cropping. The bulk of the catchment area of the river was alienated and was largely cleared of its native bushland by World War 1, but it was not until after World War 2 that the clearing of the more heavily forested areas on lateritic soils in the western parts of the catchment was undertaken. Throughout this time, the Dale River was used for domestic and stock watering and for recreation by the settlers and their families. The deep, shaded river pools were especially popular for picnics and swimming on summer weekends.

As with the Avon River, the Dale is basically a winter-flowing river. In some years it will still flow 'at a trickle' in late summer to early autumn, but in most years it dries up to a series of pools and billabongs during the summer months. The pools are a vital ecological feature as they are the principal areas in which aquatic fauna survives over the summer months and are key resting and breeding places for water birds.

These values were largely intact until the 1950s, but have since rapidly declined. The river water is now unfit for human consumption due to salt and other pollutants and is only fresh enough for stock watering. There are no deep pools left and former free-flowing tributaries, like Kettlerock Gully, are seriously choked with sediment.

The decline of the river did not happen overnight, nor were the causes immediately obvious. Changes to the river environment were incremental over decades. They are the result of

the unforeseen impacts of clearing and farming coupled with the absence of any organisation (until recently) with the task of caring for the whole river. An additional issue is that since the 1970s a new generation has grown up who did not know the river as it once was and who take the existing condition as 'normal'.

It is opportune to develop a new, shared, positive and achievable vision for the river. There is now a government agency, the Department of Water, charged with responsibility for rivercare.

The peak Natural Resource Management (NRM) body for the Avon Basin, within which the Dale catchment sits, is the Avon Catchment Council (ACC). The ACC is a non-statutory organisation based on partnership arrangements between community, government and industry to ensure sustainable use or enhancement of water, land, vegetation and other landscape assets.

The ACC has recently completed the Avon NRM Strategy and Investment Plans. The strategy provides direction and priorities for actions required for targeted resource condition change and the Investment Plans identify the resources required to 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.

The work of DoW and the ACC is supported by that of the AWC, which has a special focus on rivercare and has developed its own policies and guidelines. There are now a number of local community groups dedicated to caring for the environment and promoting agricultural sustainability.

Land use planning instruments are available to support improvement in the condition of the Dale River. At the local level, the Shire of Beverley prepares and implements a Town Planning Scheme (TPS) for the Shire. In revising the TPS, the Shire is required to consider the content of the following regional and state strategies for land use planning;

- *The Avon Arc Sub-Regional Strategy 2001*. The purpose of this strategy is to provide a regional framework for long-term land use within the Avon Arc, which includes the Dale River catchment. One of the actions for implementation states for 'Local planning documents to include guidelines to protect and manage rivers and wetlands' (p. 9) (Western Australian Planning Commission, 2001).
- *The Environment and Natural Resources Statement of Planning Policy (SPP) No. 2, 2003*. This policy has as its objectives the integration of environment and natural resource management with land use planning, the protection, conservation and enhancement of the natural environment and the promotion of wise and sustainable use of natural resources. The SPP states that 'Planning strategies, schemes and decision making should: (i) Consider mechanisms to protect, manage conserve and enhance: (b) waterways…' (p. 2051) (Western Australian Planning Commission, 2003).
- *The Draft Water Resources Statement of Planning Policy (SPP) No. 2.9, 2004*. This policy has as its first objective the protection, conservation and enhancement of water resources that are identified as having significant

economic, social, cultural and/or environmental values (Western Australian Planning Commission, 2004).

This Recovery Plan develops the overall vision for the river, and sets out a practical blueprint for action, taking into account the various background policies and the strategic approach adopted by the ACC in its 2005 Natural Resource Management Strategy and Investment Plans.

## How will the landowners along the Dale benefit from recovery of the river?

A healthy river flowing through the valley of the Dale will have many benefits to landowners living along the river and in the catchment including:

- A more attractive environment in which to live;
- The return of interesting wildlife, especially waterbirds;
- Recovery of recreational opportunities, in particular on and around the larger pools;
- Reduced flood risk;
- Increased resale value of properties;
- Sustainable agricultural production following attention to issues such as salinity, pollution and soil erosion; and
- Maintaining provision of fresher water to the Avon River.

In addition, the completion of the Recovery Plan will provide guidance for priority setting and planning by stakeholders such as DoW, ACC and Beverley Shire Council, and a basis for funding applications for catchment management and river recovery works.

## Focus of the River Recovery Plan and foreshore and channel assessment

While the focus of this River Recovery Plan and foreshore and channel assessment is the main channel of Dale River, it is recognised that in order to manage the river it is necessary also to manage the Dale's tributaries and their catchments.

There are two sorts of tributaries that flow into the Dale River. The first are the major creeks with substantial catchment areas such as Dale River South Branch, Talbot Brook, Kettlerock Gully and Geedapping Gully, which are themselves third order streams. There are also numerous small first order creeks and gullies which flow directly into the Dale from surrounding paddocks, and which usually have a catchment area of 10 hectares or less. All of the tributaries have a significant effect on the condition and health of the river as they:

- Largely determine the saltiness or freshness of the Dale;
- Are significant sources of sediment choking the river channel and pools;
- Carry pollutants into the river from farms higher in the catchment;
- Can potentially act as 'wicks' for bushfires; and
- Provide ecological links between the riverine vegetation and other bushland areas.

Therefore this Recovery Plan will also identify river recovery issues located along the tributaries and encourage good tributary management.

## Objectives

The objectives of this Recovery Plan are to;

1. Involve the Beverley and Dale communities in planning for the restoration and management of the Dale River and by doing so, to raise the profile of the river and ensure its future as a healthy waterway;
2. Identify the significant issues impacting on the health, and natural functioning of the Dale River and on heritage values along the river through a foreshore and channel assessment and community consultation;
3. Rank these issues so as to provide a basis for setting priorities for recovery actions;
4. Set out a program of actions which will steadily help to achieve the vision for the river;
5. Achieve the endorsement of the final plan by all the other agencies and organisations who have the capacity to influence the recovery of the river, in particular the ACC;
6. Ensure the River Recovery Plan provides a basis for attracting funds for river recovery works;
7. Encourage the river system to be monitored so that the success of actions over time can be measured; and
8. Encourage the Beverley and Dale communities to care for the Dale River in the future.

## The vision

As an initial step in preparing this Recovery Plan, the following vision for the Dale River was developed with the assistance of the local community.

*In 20 years time:*

- The Dale River and its tributaries will be a focus of care and responsible management in the local community, assisted by government;
- The Dale will continue to be a major source of lower salinity water flowing into the Avon;
- The restoration of pools along the Dale will have commenced;
- The whole of the main river channel will be fenced to allow control of grazing animals and regeneration of natural riparian vegetation;
- The tributaries flowing into the Dale will be fenced to permit stock management, and revegetated to protect them from erosion, sedimentation and pollution;
- Land management and farming practices will have been adopted throughout the catchment which minimise the flow of saline water, sediments and pollutants into tributaries and the Dale River;
- Important heritage sites will have been identified and protected;
- Vegetation corridors will have been established, or existing corridors protected and enhanced, to provide linkages between the river and bushland areas in the catchment;
- A program of local seed collection will have produced a stored seedbank, allowing revegetation with local provenances;
- Bushfire management programs will have been developed and implemented to prevent high intensity wildfires along the river and revegetation areas, while ensuring bushland values are retained;
- Ongoing programs will minimise the occurrence of invasive weeds and pests such as rabbits, foxes and feral cats along the river;
- The river will be free of rubbish; and
- People enjoying the river for recreation

*Image 1. Mile Pool*

will do so without damaging the riverine environment, and without causing problems to landowners along the river.

## The planning process

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

- Funding was approved through the ACC as part of the Avon Rivercare project 'On with the Job'. The funding covered:
  - The planning process and the employment of a River Recovery Planning consultant; and
  - The undertaking of the foreshore and channel assessment to investigate the current environmental condition of the river and identify management issues along the river.
- The Beverley Shire was briefed and their input and support obtained.
- Public meetings were held at Beverley and West Dale to outline the objectives of the plan, and to welcome community input.
- An advisory committee was set up with representatives from the local community, Beverley Naturalists' Club and DoW.
- A draft plan was prepared and submitted to the Shire and the local community for review
- Key organisations were identified and consulted during preparation of the plan. These included: the Shire of Beverley, Beverley and West Dale bushfire interests, land conservation interests, the Beverley Tourist Bureau, the Beverley Naturalists' Club and historical and heritage interests.

Following review and input from the community, Shire of Beverley and the AWC, the final Recovery Plan was prepared by DoW.

Implementation of the Plan will be through partnerships developed between DoE (as 'lead agency'), ACC, the Shire of Beverley, community organisations in the area and landowners.

# 3. Foreshore and channel assessment

## Focus of the foreshore and channel assessment

The foreshore and channel assessment looked at the condition of the foreshore and channel areas of the Dale River between April and July 2005. Figure 4 shows a cross section of a typical river valley and illustrates the area covered in the assessment.

Foreshore and channel assessment was used to capture a 'snapshot' of the environmental condition of the Dale River in order to:

- Identify areas within the riparian environment in need of restoration and management;
- Provide river managers with current information about the state of the Dale River to aid in decision making, especially in the prioritisation of future restoration works through the River Recovery Planning process;
- Provide baseline information to allow changes in riparian health to be measured;
- Provide information to landowners and the community about the causes and management of waterway degradation processes; and
- Provide a reliable technical basis for future funding submissions.

## Community awareness and involvement

A letter of introduction was sent out to landholders along the Dale River explaining the purpose of this survey. Arrangements were then made to gain access to properties to survey the river. Letters were also sent out to other stakeholders, including the Shire of Beverley and Beverley Naturalists' Club.

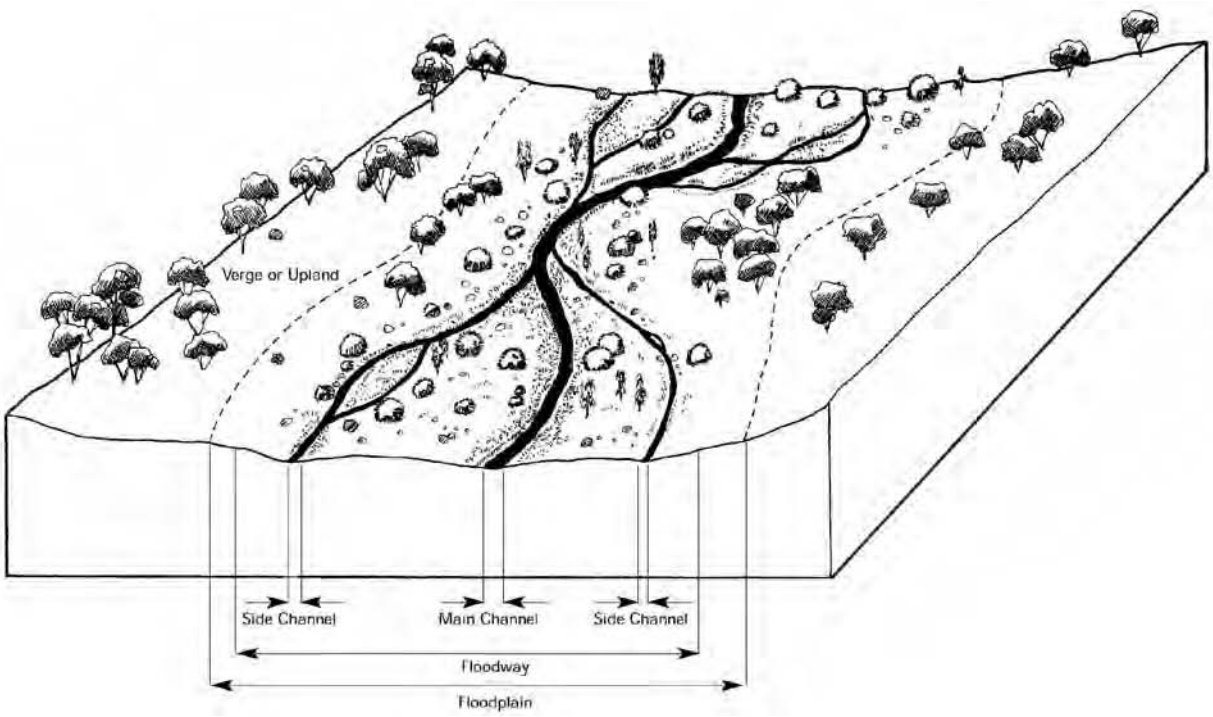



*Figure 4. Cross section of a typical river valley and the terms used to describe it (Source: Pen and Scott, 1995)*

## Foreshore and channel assessment technique

A Foreshore and Channel Condition Assessment Form (refer to Appendix 5) was adapted from Pen and Scott, 1995 to standardise the field surveys. The river was divided into sections primarily based on property and/or paddock boundaries but also taking into account the landform and general foreshore condition. Sections were numbered 1 through to 60 starting at the confluence with the Avon River and working upstream towards the headwaters. Left and right banks of the river were therefore determined facing upstream.

For each section the following information was collected for both river banks:

- General details including GPS coordinates for the start and end of the section;
- Bank stability;
- Waterways features;
- Vegetation health;
- Habitat available for aquatic and terrestrial animals;
- Habitat diversity;
- General landform;
- Fencing status;
- Foreshore condition (see explanation below);
- Overall steam environmental health rating (see explanation below);
- Evidence of management;
- Management issues such as fire, weeds and erosion;
- Ideas for management such as fencing, weed and erosion control;
- Vegetation (both native and introduced); and
- Water quality data.

Photos were taken to develop a pictorial record and these have been filed at DoW Northam.

Landholders were also asked about changes in waterway health and condition, historical water levels, past land use and management of the river.

Where plant species could not be identified in the field, samples were collected for later identification. A *Licence for Scientific or other Prescribed Purposes* was obtained from the Department of Conservation and Land Management (CALM), giving permission to collect flora for scientific and identification purposes.

The assessment form is comprehensive in recording foreshore and channel condition but does not require specialised knowledge or extensive technical assistance to complete. Hence community groups and individuals can easily undertake assessments. The form is divided into a number of sections (as outlined above). In this survey of the Dale River the assessors collected information under the majority of the sections, however assessors can make use of the sections that are relevant to their needs. The blank assessment form provided in Appendix 5 can be copied and used by interested community groups and individuals.

### Bank stability

Erosion is a naturally occurring process even in pristine waterways, however in waterways in good condition erosion is generally only present on meander bends. Badly eroded banks and sediment heaps indicate poor waterway health. Bank erosion results from a lack of fringing vegetation to stabilise and protect banks and physical trampling of the banks by livestock (Pen, 1999; Water and Rivers Commission, 1999a).

Bank stability was assessed by observing the proportion of the banks affected by

erosional processes including undercutting, firebreak and track washout, subsidence, gully erosion, sedimentation and slumping (Table 3). General evidence of streambank erosion includes widening streamlines, incised channels, bare soil on the top of banks, vertical banks and exposed tree roots.

*Table 3. Rating system used to determine bank stability*

| Proportion (%) of river bank affected | Rating |
|---|---|
| 0–5% | Minimal |
| 5–20% | Localised |
| 20–50% | Significant |
| > 50% | Severe |

Undercutting (Image 2) occurs on vertical banks where an increase in flow velocity causes the channel to incise. The scouring action of the water against the banks causes the banks to become undercut. Eventually the undercut bank, with no support from below, will collapse. This process is called slumping (Image 3). Subsidence is another form of bank collapse where flows saturate banks and cause them to collapse under the added weight of the water (Pen, 1999).

Washouts occur where sandy soils are exposed on the floodplain, usually along tracks and firebreaks. During floods these areas are scoured out and the scour grows in size with each successive flood. Washouts can also occur when the main channel becomes clogged with sediment and debris and flood flows are unable to move through the channel. Instead, flows move across the floodplain eroding vulnerable areas (Pen, 1999).

Gully erosion (Image 4) refers to the formation of a deep channel (> 30cm) where once there was only a shallow depression. A common way gullies form is through headcutting. Headcutting is where a stream erodes upstream from a point and occurs where the slope of the channel suddenly increases. The flow velocity consequently increases, scouring the soil over the face of the slope (Pen, 1999).

Sedimentation (Image 5) is where coarse sediments, eroded from upstream, are deposited in bars or slugs in the channel or river pools. Sediment slugs smother aquatic habitat and can slow down flow and cause localised flooding upstream as well as redirect flow into banks causing further erosion (Pen, 1999).

## Waterway features

The presence of waterway features such as deep pools, anabranches, groundwater seepage, riffles, tributaries, large woody debris and sand slugs were noted for each section. The presence or absence of certain features can give indications of the health of the waterway. The presence of deep pools, anabranches, riffles and vegetated islands can indicate that the waterway is in reasonable health. Other features, such as sand slugs, on-channel dams and other man-made structures may be related to poor waterway health.

## Vegetation assessment

Vegetation health and structure is linked to stream health and plays a vital role in bank stability. Vegetation health was assessed to identify sections of foreshore that may become unsupported in the near future (Water and Rivers Commission, 1999a). While detailed floristic surveys were not completed, an effort was made to identify the native and introduced plant species in each section to give an indication of the diversity of plant species in the riparian zone. However, the vegetation list is not exhaustive and there are likely to be plant species, especially introduced species, that are present in the riparian zone but were not recorded during the survey. Other vegetation characteristics including

*Image 2. Undercutting of the bank, exposing plant roots*

*Image 3. Slumping, where an undercut bank has collapsed under its own weight*

*Image 4. A gully, formed by headcutting along a small tributary*

*Image 5. Severe sedimentation in the main channel of the Dale River*

vegetation health, the amount of leaf litter present, the types of instream cover and the relative abundance of native and exotic plant species were also assessed.

An extensive knowledge of plants is not needed to complete the vegetation health and species list sections of the survey form. A simple score of the number of native and exotic plant species in each vegetation layer (overstorey, middlestorey and understorey) and their relative abundance would still give a clear indication of plant species diversity and the relative balance between native and introduced species.

### Habitat diversity

A wide diversity of aquatic and terrestrial habitats is necessary for waterways to support a diversity of life. There is also a need for these habitats to be in good condition and to be connected, as some fauna require several habitat types to complete their life cycle. Information was collected during the survey on whether different aquatic and terrestrial habitats, such as pools, instream rocks and logs, protected basking sites and a variety of vegetation types, were present but not on their condition or connectivity. Observations were also made on water quality and variation in water depth, for example the presence and location of debris and the height above the current water level of undercutting.

An effort was made to identify wildlife, including birds, reptiles and mammals (both native and introduced) by sight or call. Where possible birds were categorised as being woodland, shrubland, heathland or farmland birds, depending on their habitat preference and as being priority, remnant dependent or farmland species. Priority species are those that are likely to be lost from the landscape if nothing is done to protect their habitat. Remnant dependant species primarily use remnant bushland for habitat and are likely to decline in numbers if remnant vegetation is lost or degrades. Farmland birds generally inhabit farmland areas but may also use remnant bush and may decline if remnant vegetation is lost or degrades (Greening Australia Western Australia, 2004).

### Fencing status

Fencing is the easiest way to exclude stock from sensitive foreshore areas and protect vegetation and banks. For each section it was recorded whether or not a fence was present, the condition of the fence, the material used in constructing the fence and whether there was stock and vehicle access to the foreshore, for example gate access and/or signs of stock within the riparian zone. Rather than average the condition of the fence along each section, GPS was used to record points at which the fence condition changed. Photographs in Appendix 6 show examples of good, moderate and poor fence condition.

### Foreshore condition rating system

One of the main pieces of information collected about the health of the Dale River was the foreshore condition rating of each section. The rating indicates the level of degradation by characterising the foreshore in terms of vegetation structure, the balance between native and exotic vegetation and bank stability. Both an overall rating and a ‘best’ and ‘worst’ rating were recorded. The overall rating of each section was determined as the average rating along the whole length of the section and was recorded as A-grade (pristine) through to D-grade (eroding ditch). The ‘best’ and ‘worst’ ratings were respectively the highest and lowest ratings determined within the section and were recorded as A1 (pristine) through to D3 (weed-infested

drain). The first 300 to 500 m of significant tributaries were also given a general foreshore rating of A-grade through to D-grade. Appendix 7 shows diagrammatically the overall foreshore condition ratings and a description of each rating and its sub-grades is outlined below.

### *A-grade foreshore*

For a section to be rated as A-grade, the riparian zone must be entirely vegetated with native species. Some weeds may be present but native species still dominate the understorey and there is little or no evidence of disturbance from human activities or feral animals. This general rating is further divided to reflect the level of weed invasion and disturbance.

| **Rating** | **Key features** |
|---|---|
| A1 Pristine | The river embankments and floodway are entirely vegetated with native species and there is no evidence of human presence or livestock damage |
| A2 Near pristine | Native vegetation dominates. Some introduced weeds may be present in the understorey but not as the dominant species. Otherwise, there is no evidence of human impact |
| A3 Slightly disturbed | Native vegetation dominates, but there are some areas of human disturbance where soil may be exposed and there are local weed infestations along tracks. Native vegetation would quickly recolonise if human disturbance declined |

### *B-grade foreshore*

A general B-grade foreshore rating is given to sections where the majority of the vegetation structure is intact but where the understorey has been invaded by weeds. The sub-grades are divided based on the level of weed invasion and its affect on the regeneration of some shrubs and trees.

| Rating | Key features |
|---|---|
| B1 Degraded – weed infested | Weeds have become a significant component of the understorey vegetation. Native species are still dominant but a few have been replaced by weeds |
| B2 Degraded – heavily weed infested | Understorey weeds are nearly as abundant as native species. The regeneration of trees and large shrubs may have declined |
| B3 Degraded – weed dominant | Weeds dominate the understorey, but many native species remain. Some trees and large shrubs may have disappeared |

### *C-grade foreshore*

A C-grade foreshore rating indicates that the foreshore supports only trees over weeds or pasture. As a result of the dominance of weeds in the understorey, bank erosion and subsidence occur in localised areas. The sub-grades for this rating are divided based on the amount of ground cover provided by weeds and the susceptibility of the banks to erosion.

| **Rating** | **Key features** |
|---|---|
| C1 Erosion prone | Trees remain with some large shrubs and the understorey consists entirely of weeds (ie annual grasses). There is little or no evidence of regeneration of tree species. River embankment and floodway are vulnerable to erosion due to the shallow-rooted weedy understorey providing minimal soil stabilisation and support |
| C2 Soil exposed | Older trees remain but the ground is virtually bare. Annual grasses and other weeds have been removed by livestock grazing and trampling or through humans use and activity. Low level soil erosion has begun |
| C3 Eroded | Soil is washed away from between tree roots. Trees are being undermined and unsupported embankments are subsiding into the river valley |

### *D-grade foreshore*

A D-grade foreshore rating indicates that there is not enough remaining vegetation to control erosion and the waterway is little more than an eroding ditch or weed-infested drain. Sub-grades are determined by the amount of vegetation present and the severity of erosion.

| Rating | Key features |
|---|---|
| D1 Ditch – eroding | There is not enough fringing vegetation to control erosion. Remaining trees and shrubs act to impede erosion in some areas, but are doomed to be undermined eventually |
| D2 Ditch – freely eroding | No significant fringing vegetation remains and erosion is out of control. Undermined and subsided embankments are common. Large sediment plumes are visible along the river channel |
| D3 Drain – weed dominant | The highly eroded river valley has been fenced off, preventing control of weeds by stock. Perennial weeds have become established and the river has become a simple drain |

## Water quality data

Water quality data (pH, salinity, temperature and turbidity) was collected during the survey in some sections of the main channel and some tributaries. A water quality snapshot was undertaken on 17 June 2005. Salinity, temperature, turbidity and pH were recorded at 18 sites on the main channel of the Dale River and a number of tributaries including Talbot Brook, Dale River South Branch, Turner Gully and Kettlerock Gully. These results are discussed in Chapter 1 and detailed in Appendix 2.

## Overall environmental stream health rating

Each section was given an overall environmental stream health rating, which gave an indication of overall stream health based on an assessment of the quality and diversity of riparian habitats. The following factors were used to assess the health of the waterway:

- Floodway and bank vegetation;
- Verge vegetation;
- Stream cover;
- Bank stability and erosion;
- Habitat diversity; and
- Surrounding land use.

Each of the factors (with the exception of landuse) was rated from excellent to very poor (Table 4). A numerical score was given for each rating. Scores were weighted to give more importance to those factors more vital to stream health, such as shade and permanent water, which are both very important for aquatic life during hot, dry summers (refer to Appendix 8). The overall environmental health rating was derived from the summation of the individual scores.

A rating of excellent would indicate that the bank and verge vegetation was intact with no weeds present, providing a variety of habitats for aquatic and terrestrial fauna, and stream cover in the forms of shade, leaf litter and branches. Due to the presence of pristine vegetation, there would be minimal erosion and no bank disturbance. On the other end of the scale, a rating of very poor would indicate that the waterway was highly degraded with virtually no vegetation cover, resulting in no stream cover, a lack of habitat for aquatic and terrestrial fauna and continuous bank erosion.

*Table 4: Scores for the overall stream environmental health rating*

| Score | Rating |
|---|---|
| 40–55 | Excellent |
| 30–39 | Good |
| 20–29 | Moderate |
| 10–19 | Poor |
| 0–9 | Very poor |

# 4. Findings from the foreshore and channel assessment

## Foreshore condition

### General foreshore condition

The overall foreshore rating was determined as the average rating along the whole length of the surveyed section. Ninety-three per cent of sections are rated as C-grade foreshores (Maps 3.1 and 3.2). The general C-grade rating reflects that the riparian zone is characterised by trees and shrubs over weeds or pasture and that the banks and floodway show localised erosion, or are vulnerable to erosion, due to the minimal bank support provided by the shallow-rooted, weedy understorey.

The factors that have probably contributed to the overall C-grade rating include:

- Stock access to the banks and channel, which has degraded fringing vegetation, decreased bank stability, encouraged the spread of weeds and prevented native species from regenerating;
- A decline in water quality due to widespread land clearing for broad scale agriculture; and
- The surrounding agricultural landuse.

Five per cent of sections are rated as B-grade, where the vegetation structure is mostly intact but where weeds have invaded the understorey. There is one A-grade section where the riparian zone is almost entirely vegetated with native species and has limited areas of disturbance.

The foreshore condition of the first 300 to 500 m of seventeen of the Dales' significant tributaries were assessed. Seventy-six per cent are rated as C-grade and 24% as D-grade. Most of the tributaries are not fenced and weed invasion, erosion and sedimentation are significant problems. It is likely that a significant amount of sediment and other pollutants, such as nutrients, are being contributed to the main channel from these waterways.

### Best foreshore condition

The 'best' foreshore rating was given as the highest rating within each section and varied from A3 down to D1 (Maps 4.1 and 4.2). Sixty-three precent of sections have a best foreshore rating of C1. C1 foreshores along the Dale River have an overstorey of trees and large shrubs over an understorey dominated by weeds, and as a result, the banks are vulnerable to erosion.

### Poorest foreshore condition

The 'poorest' foreshore rating was given as the lowest rating within each section and varied from A3 down to D1 (Map 5.1 and 5.2). Forty-two per cent of sections are rated as C1. Twelve per cent of sections have reaches rated as D1, where there is not enough fringing vegetation left to control erosion and the remaining vegetation is being undermined.

## Bank and channel stability

Undercutting, erosion and sedimentation are the main forms of channel instability (Table 5). Undercutting is evident on vertical banks where an increase in flow velocity had caused the channel to incise and the banks to undercut due to the scouring action of the water. As in other catchments widespread land clearing, which results in an increase in runoff, is the cause of relatively larger and faster flows in the Dale. Erosion, which is evident from widened channels, incised banks and bare soil on banks, and sedimentation problems are likely to be linked mainly to stock access.

*Table 5. Percentage of sections scored under each bank stability rating*

| Rating | Erosion process | | | | | | |
|---|---|---|---|---|---|---|---|
| | Undercutting | Track washout | Subsidence | Erosion | Gully erosion | Sedimentation | Slumping |
| Minimal | 25 | 100 | 100 | 52 | 100 | 75 | 100 |
| Localised | 72 | | | 30 | | 17 | |
| Significant | 3 | | | 18 | | 7 | |
| Severe | | | | | | 2 | |

Sedimentation problems are not necessarily caused by bank erosion in the local area. Sediment slugs were often deposited where the channel form changed and the flow velocity slowed, for example in many of the large river pools. Another likely source is sediment washed off paddocks in overland flow, especially in areas where there is little fringing vegetation to filter runoff water. There is evidence from the survey that many of the tributaries, including Kettlerock, Connelly and Turner gullies and some unnamed tributaries, contribute significant amounts of sediment to the Dale River.

Fringing vegetation plays a vital role in bank stability. The network of plant roots physically binds the banks together, minimising the amount of soil washed away, and the presence of vegetation on the banks and in the channel itself slows water velocity and reduces the scouring power of the flow (Pen, 1999). The floodway and bank vegetation along the Dale River is generally classified as moderate, reflecting that while overstorey and middlestorey vegetation is present, the understorey is mainly exotic weeds which don't have the same capacity as native plants to protect banks from the scouring action of water.

## Fencing

Most of the Dale River is fenced, with 51.2 km (77.5%) of the left bank and 49.8 km (76.3%) of the right bank having some form of fencing. Only 14.8 km of the left bank and 15.5 km of the right bank are unfenced (Maps 6.1 and 6.2). Most of the fencing is in good or moderate condition and is stock proof (Table 6).

*Table 6. Fence condition along the left and right banks of the Dale River*

| Fence condition | Percentage of left bank | Percentage of right bank |
|---|---|---|
| Good | 37.7 | 40.3 |
| Moderate | 27.4 | 26.4 |
| Poor | 12.4 | 9.6 |
| No fence | 22.4 | 23.7 |

The presence of fencing does not necessarily indicate that stock are permanently excluded as in 70% of sections signs were found indicating that stock have access to the foreshore area. Most sections were vehicle accessible (Maps 7.1 and 7.2).

Ideally fences along a major waterway, such as the Dale River, should be a minimum of 30 m away from the edge of the channel although the appropriate distance depends on the shape and width of the river valley. This recommendation takes into account the functioning of the waterway as well as the potential for flood damage to fencing and stock (Water and Rivers Commission, 2000e). The majority of the fencing along the Dale River is either greater than 30 m or between 10-20 m away from the channel. Only a small percentage of fences are less than 10 m away from the river (Table 7).

*Table 7. Fence distance from the main channel of the Dale River*

| Fence distance | Percentage of left bank | Percentage of right bank |
|---|---|---|
| < 10 m | 6.2 | 11.3 |
| 10-20 m | 24.4 | 27.7 |
| 20-30 m | 14.3 | 7.9 |
| > 30 m | 29.4 | 26.8 |
| Not recorded | 3.3 | 2.6 |
| No fence | 22.4 | 23.7 |

## Waterway features

The general river landform changes over the length of the river. In some reaches of the river, there is a single channel and in others the channel is braided. Near the headwaters, there is no defined channel.

Upstream from the confluence with the Avon River, the river has an incised main channel with numerous anabranches and is set within a broad, relatively shallow river valley with a floodplain approximately 100 m wide. Laterite outcropping is relatively common within the floodplain.

Towards the headwaters in the Darling Range, the main channel becomes less incised and the surrounding valley slopes relatively steeper. The floodplain narrows to approximately 60 m wide, and granite outcropping and groundwater expression occur within the floodplain.

The Dale River has numerous tributaries of varying sizes. All up, 42% of sections have tributaries and they range from minor depressions, which only flow in large rainfall events, to significant creeks that contribute relatively large volumes of water to the Dale River.

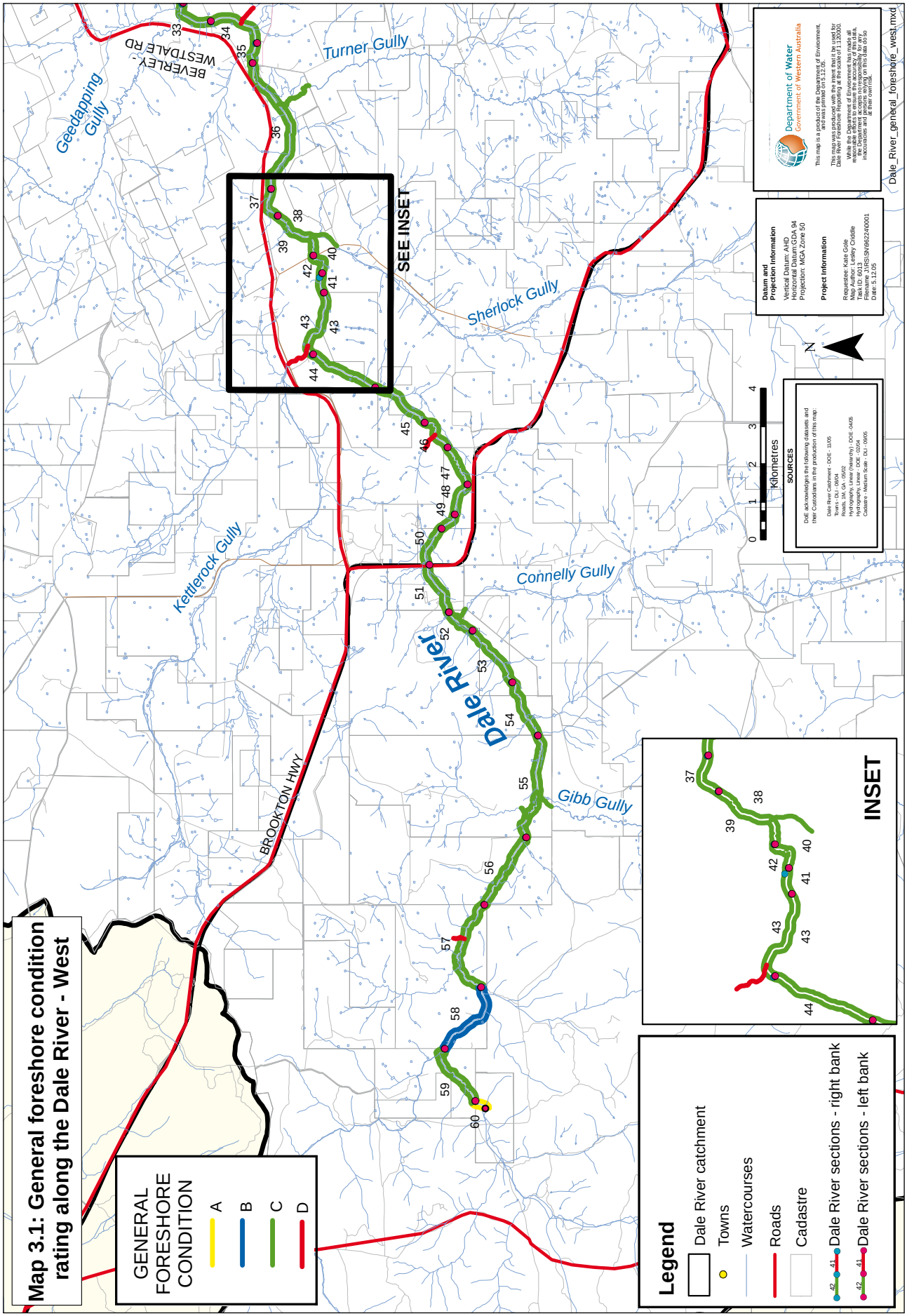
The Dale River has a variety of waterway features corresponding to broad habitat zones within the channel and floodway. Large woody debris is present in 95% of sections. It is important as it slows water velocity and physically protects banks from erosion as well as providing woody habitat and shelter to numerous aquatic animals.

Anabranches, or side channels, are common features of many of the waterways in the Avon catchment and the Dale River was no exception with side channels in 88% of sections. When dry, anabranches are similar to the rest of the floodplain and are important areas for nutrient cycling and habitat for terrestrial animals and plants adapted to periodic waterlogging and inundation. When wet, anabranches are connected to the main channel, conduct flow and are important sources of organic matter (from accumulated debris). They also provide habitat for birds, fish, frogs and aquatic invertebrates (Land and Water Australia, undated).

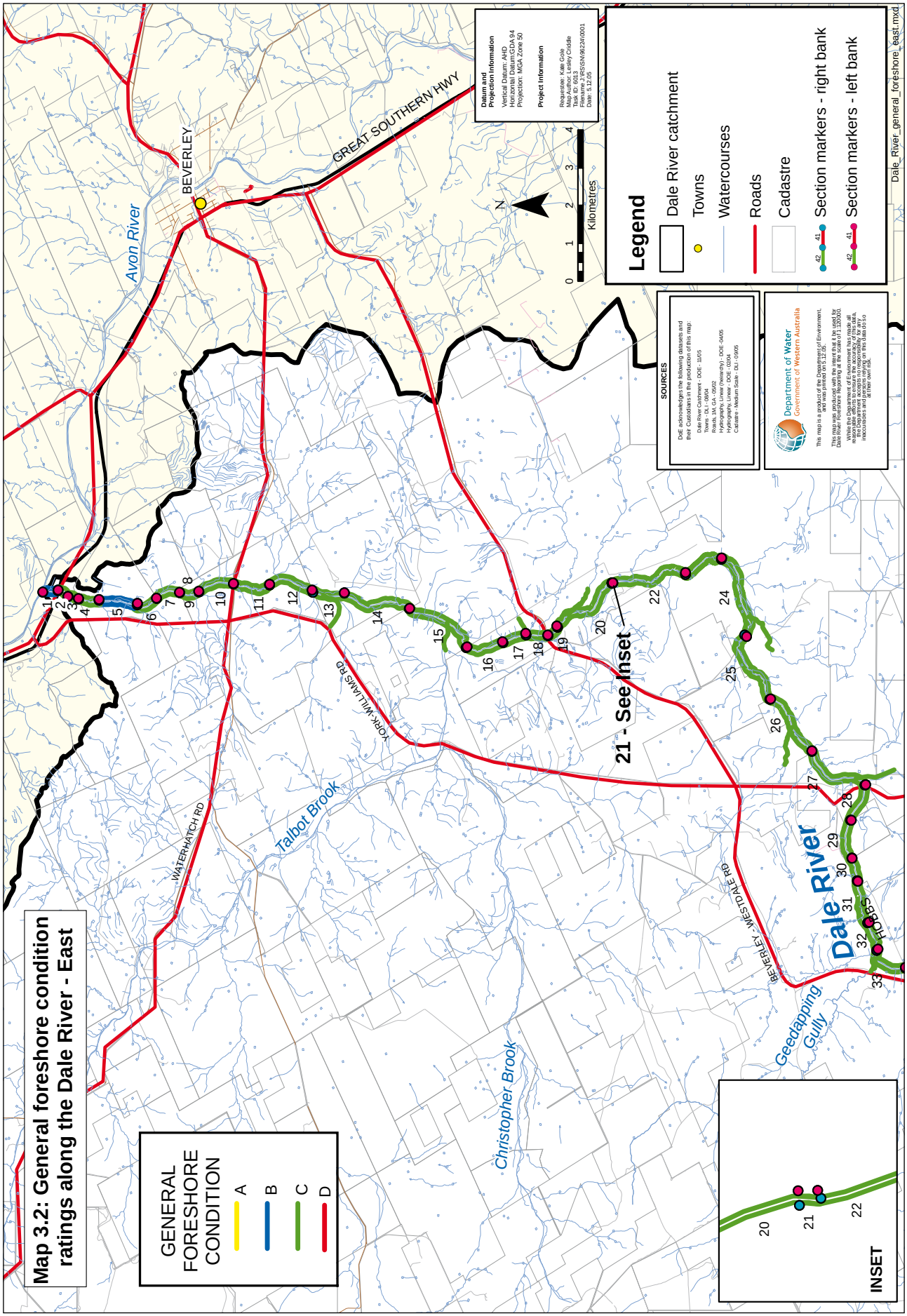
Because the main channel of the Dale is incised in many areas, the connectivity between the river and it's floodplain has been altered. A deeper channel means that larger flows are needed to flood the side channels and floodfringe. This has consequences for the overall productivity of the river system, as less organic matter is available for instream foodwebs, and results in less habitat for the plants and animals reliant on side channels and the wetter areas of the floodfringe.

Riffles, present in 48% of sections, provide important habitat for aquatic invertebrates. They aerate the water and trap sediment, therefore contributing to maintaining water quality. The majority of the riffles along the Dale River are formed from logs although there are a number of natural rock riffles. There are also a number of rock crossings that act as riffles and sediment traps.

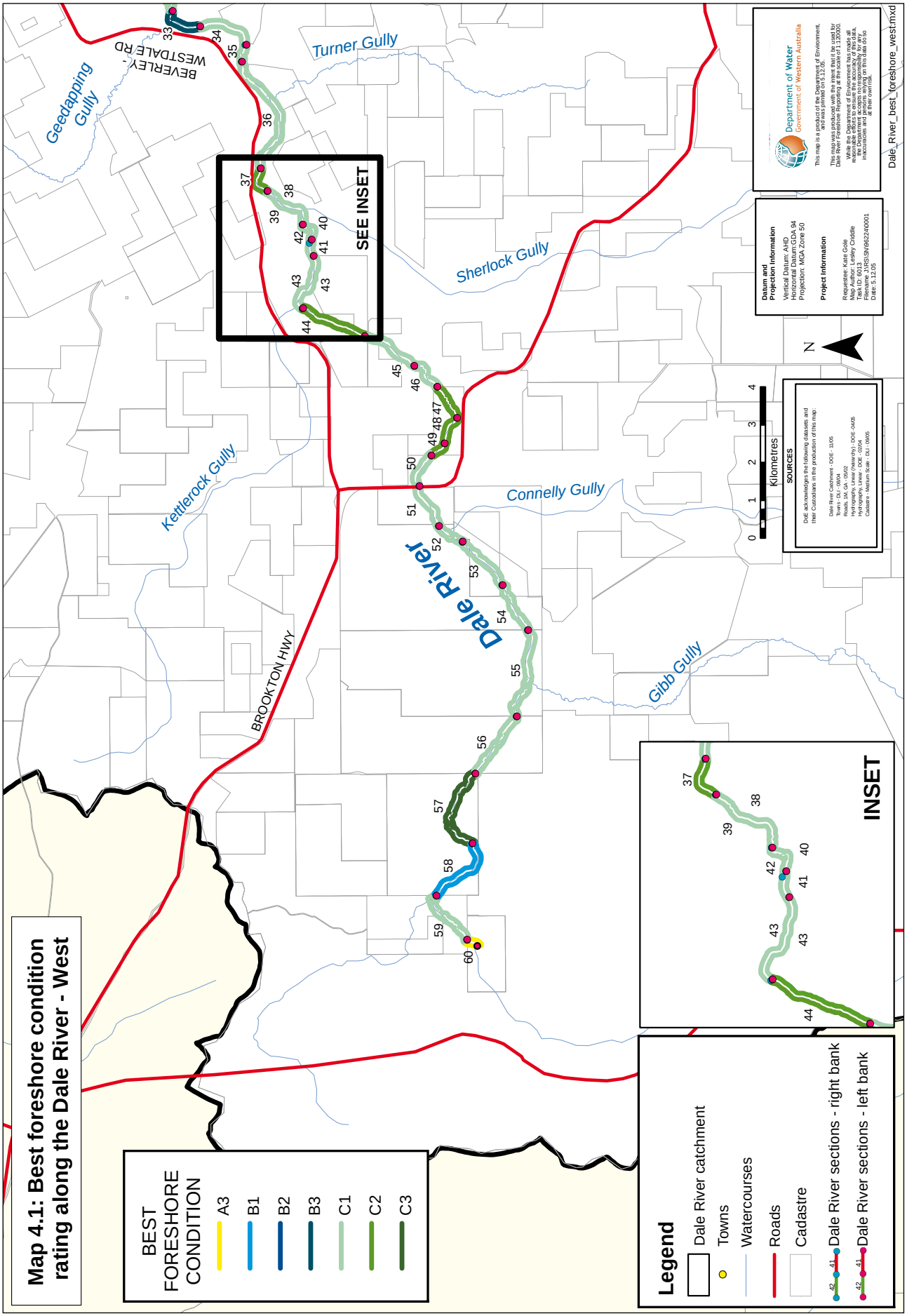
River pools, present in 40% of sections, are a vital refuge for plants and animals, both aquatic and terrestrial, during summer drought as they are the only source of permanent water.



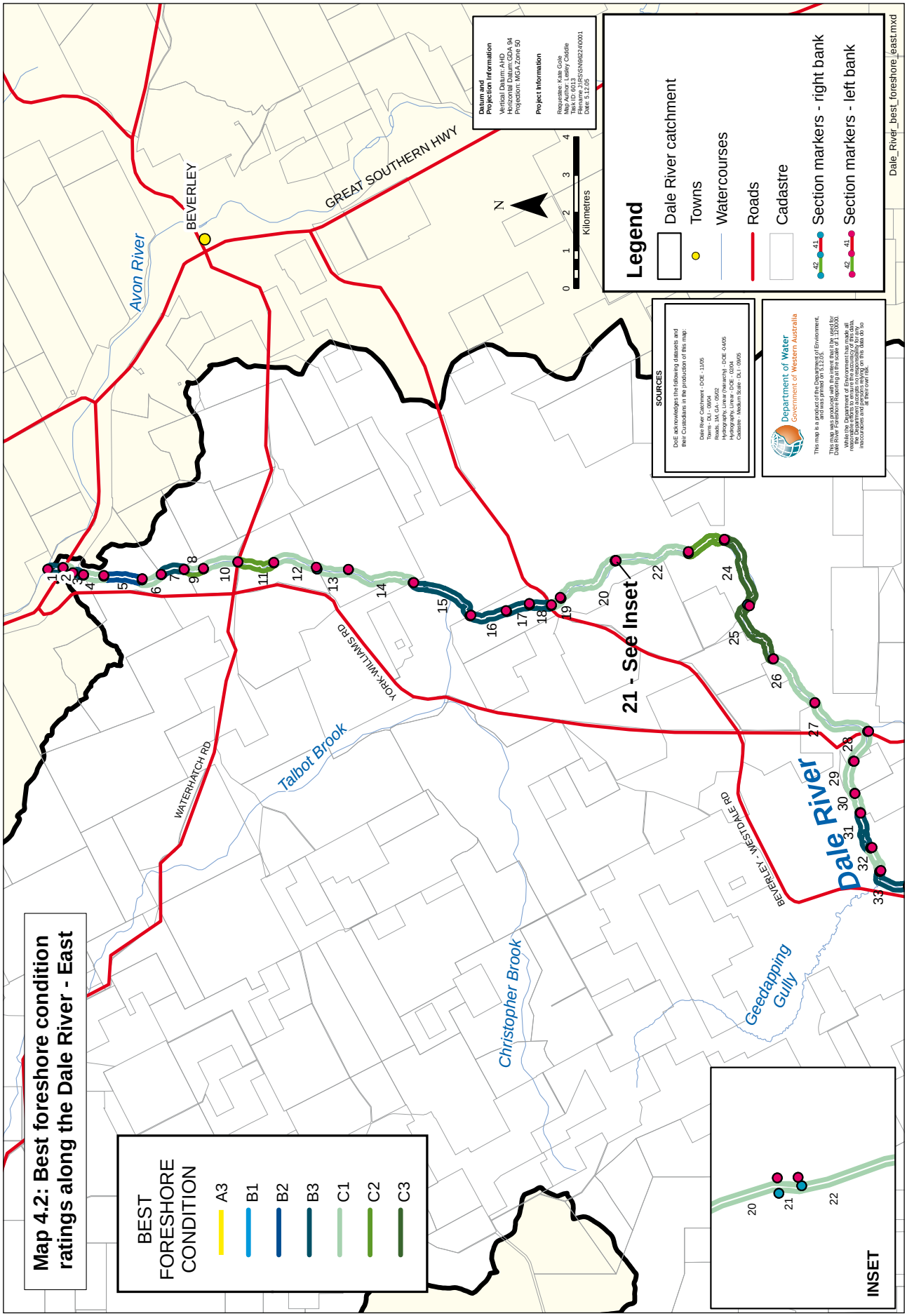

*Map 3.1. General foreshore condition rating along the Dale River – West*



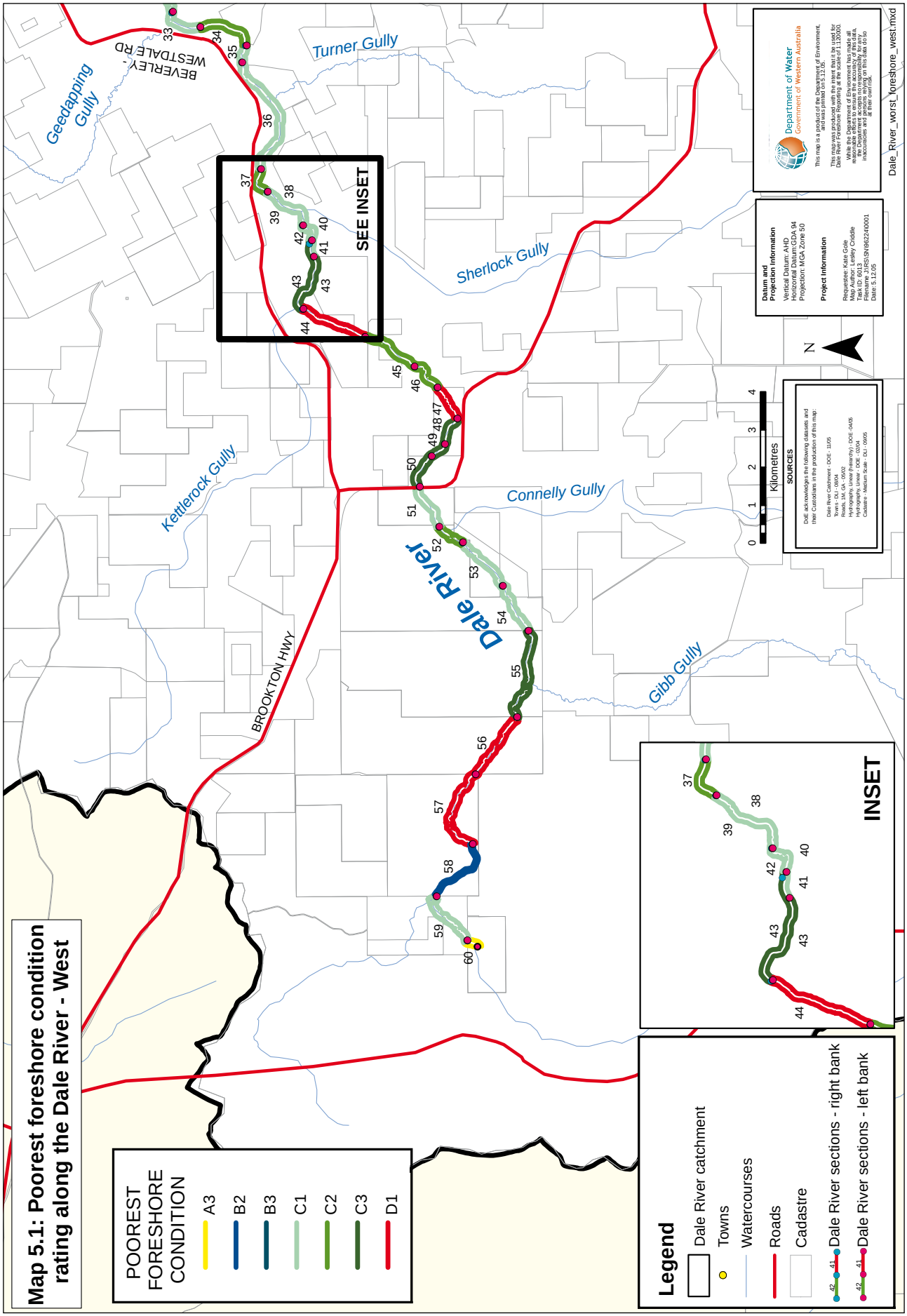

*Map 3.2. General foreshore condition rating along the Dale River – East*



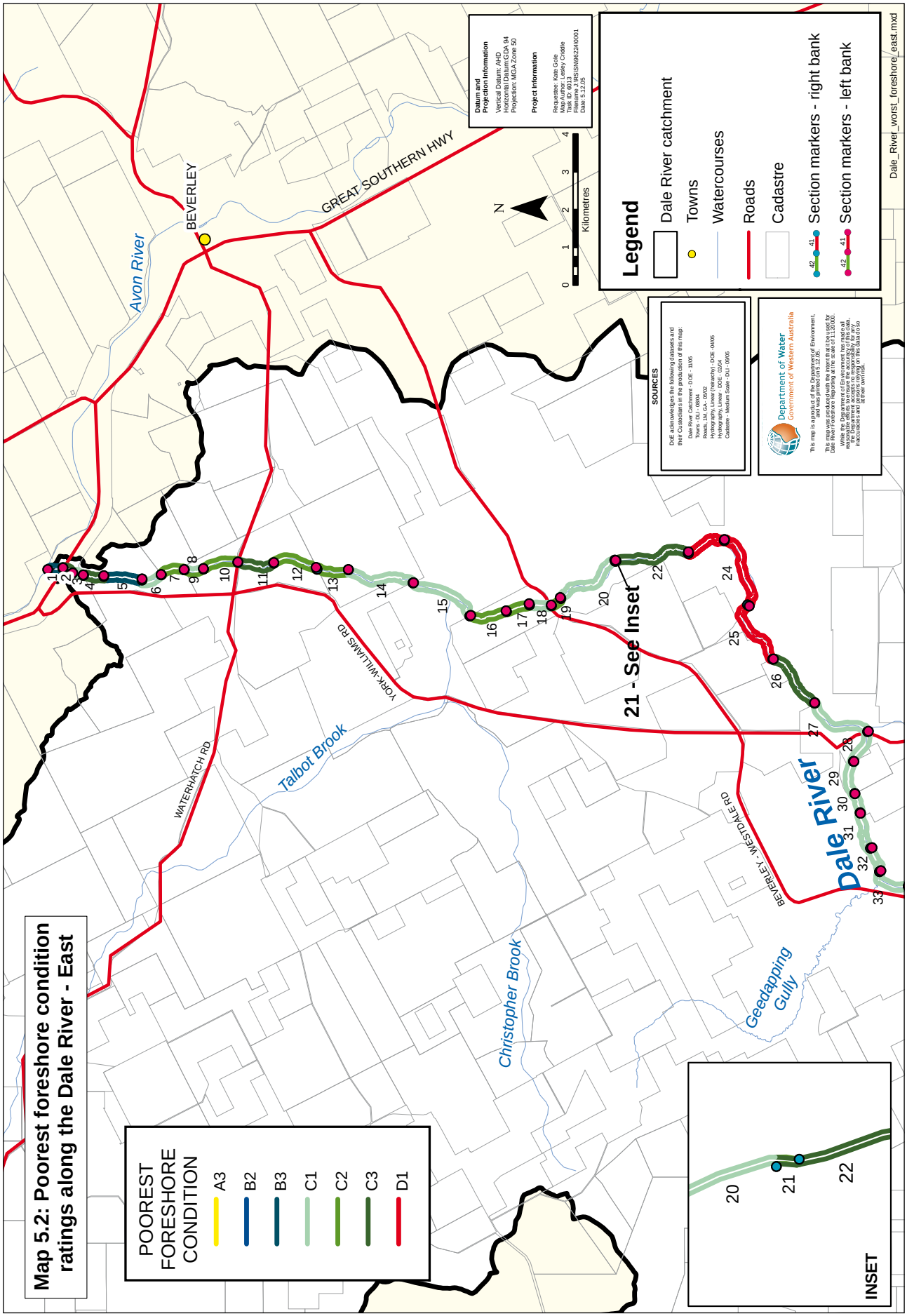

*Map 4.1. Best foreshore condition rating along the Dale River – West*



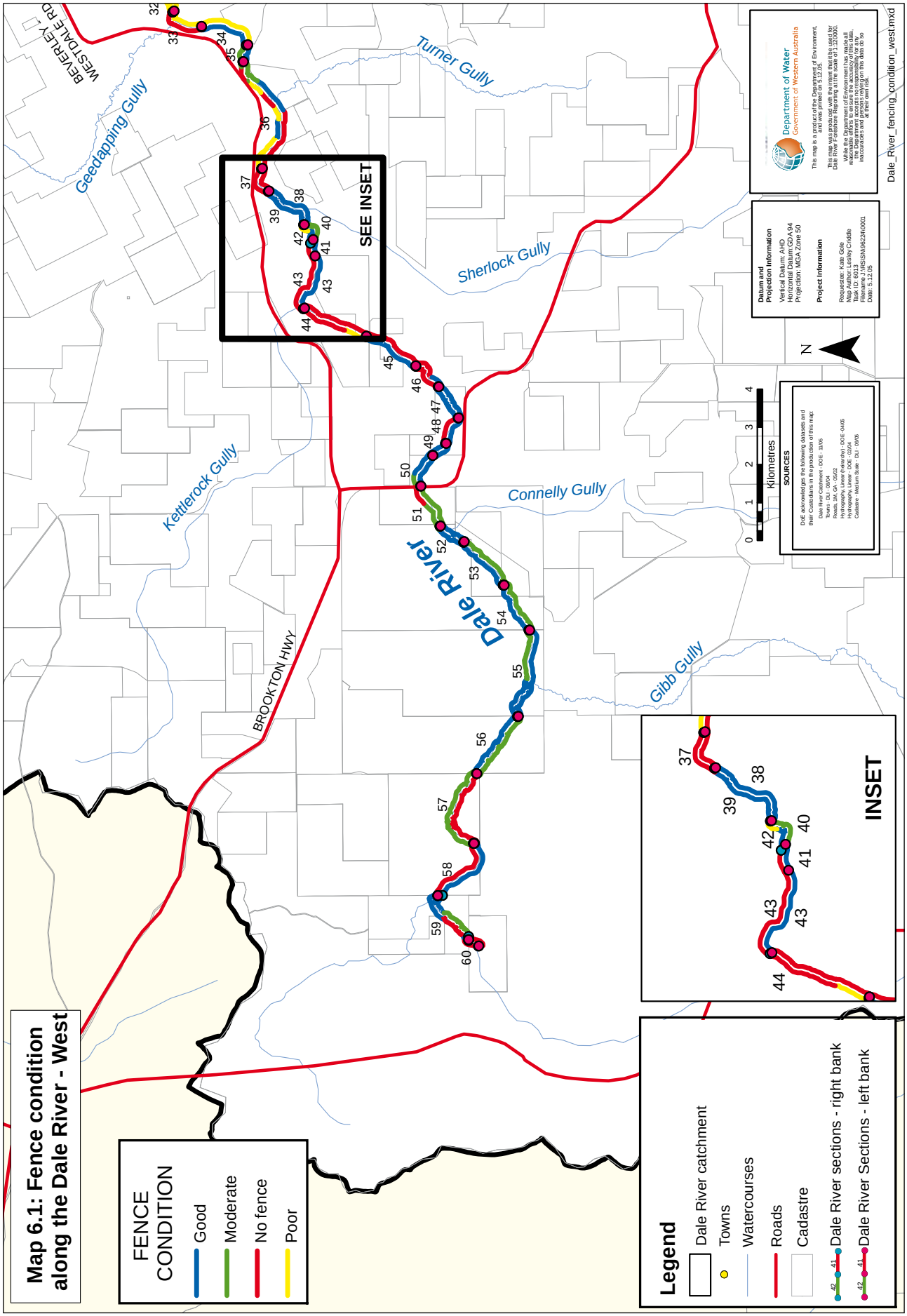

*Map 4.2. Best foreshore condition rating along the Dale River – East*



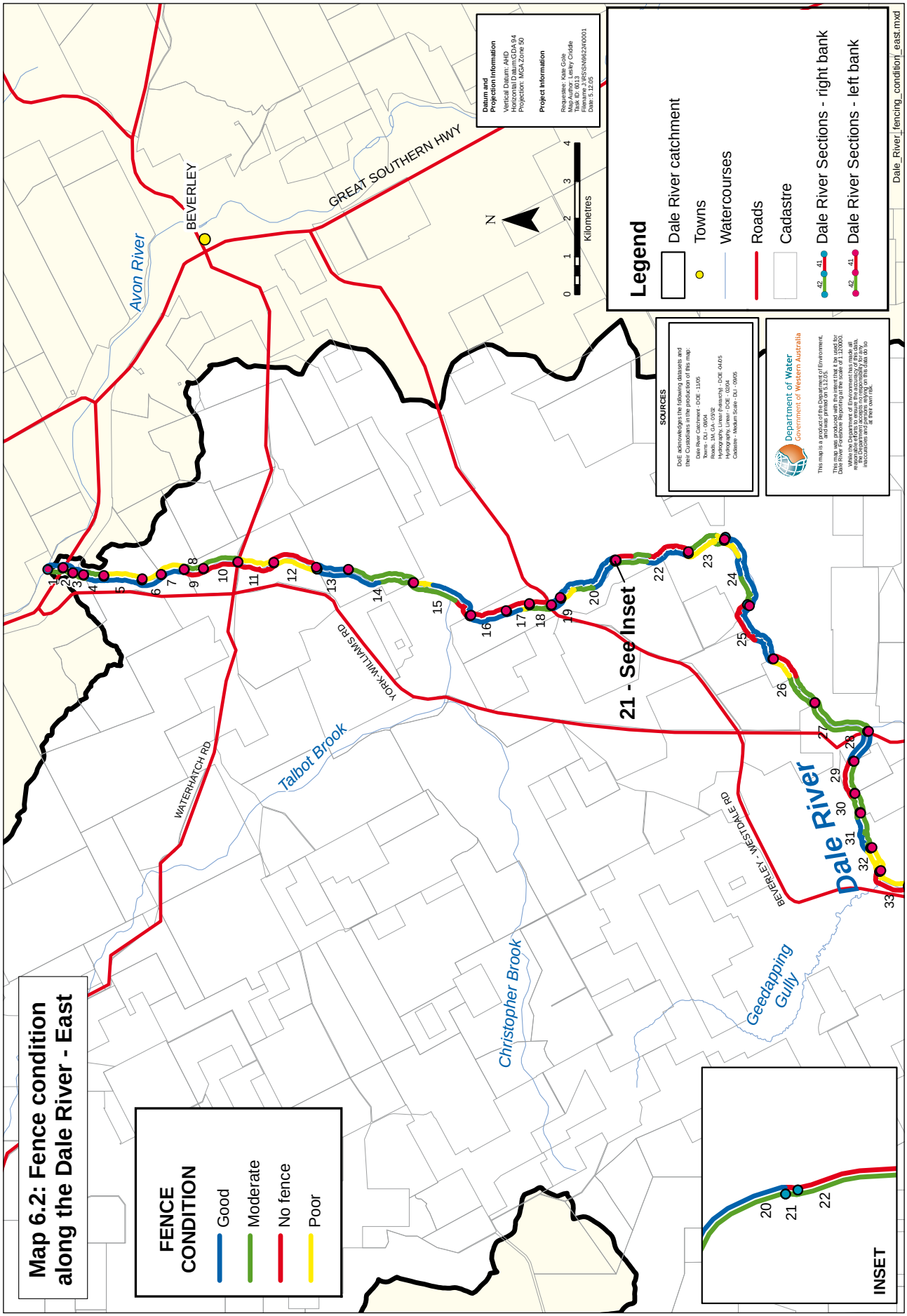

*Map 5.1. Poorest foreshore condition ratings along the Dale River – West*



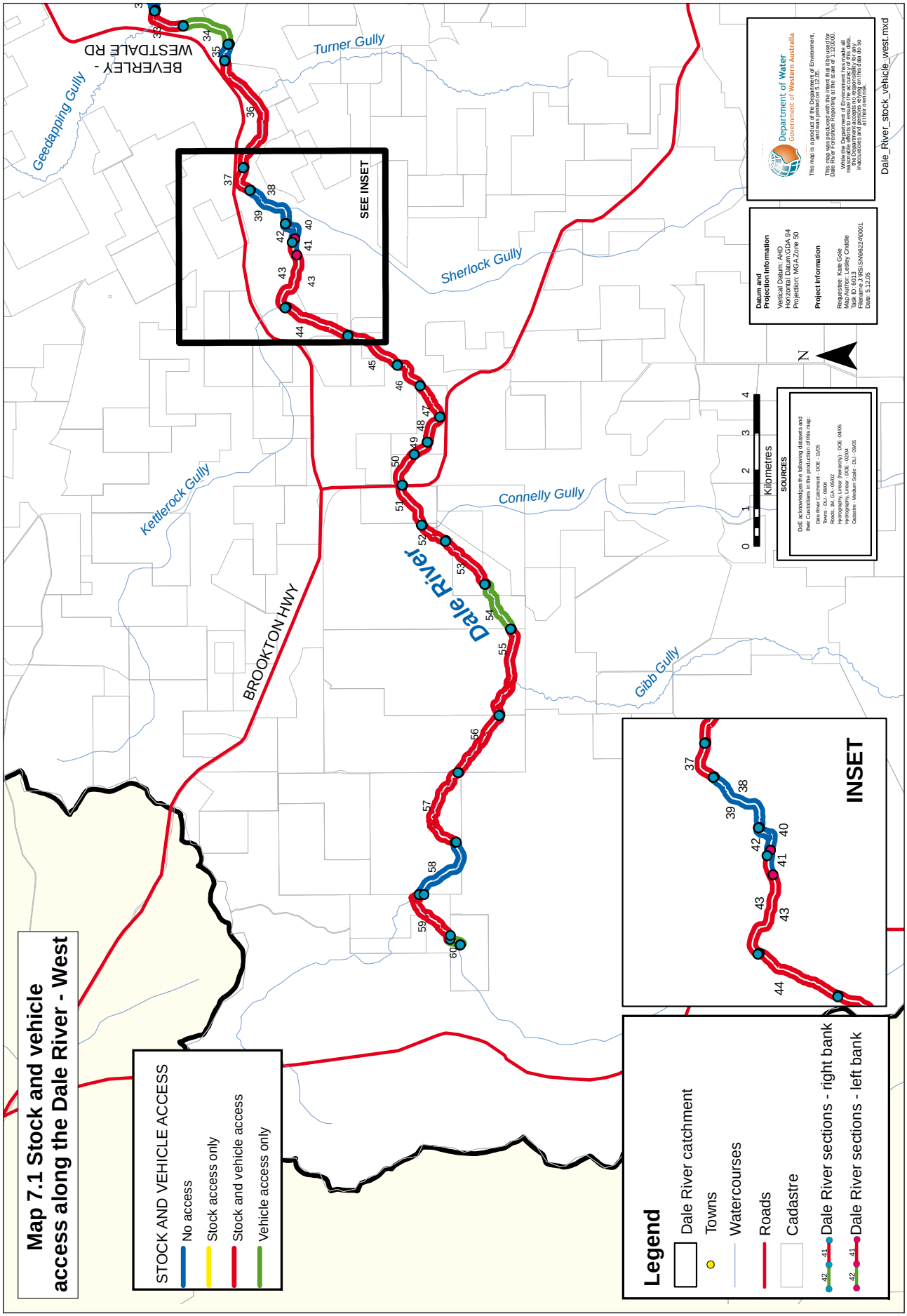

*Map 5.2. Poorest foreshore condition ratings along the Dale River – East*



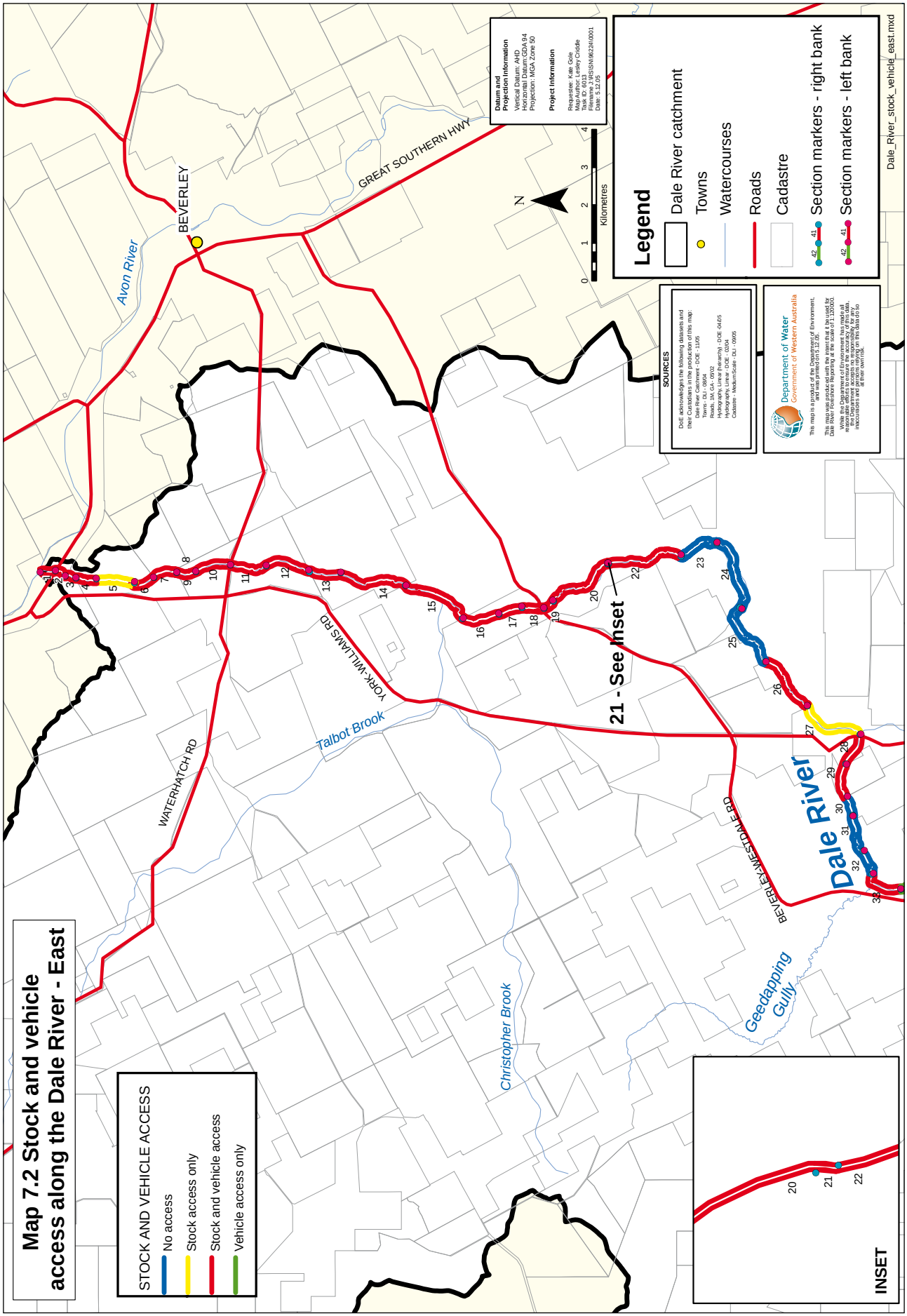

*Map 6.1. Fence condition along the Dale River – West*




*Map 6.2. Fence condition along the Dale River – East*




*Map 7.1. Stock and vehicle access along the Dale River – West*




*Map 7.2. Stock and vehicle access along the Dale River – East*

Sediment slugs are present in 73% of sections. While sediment can prevent channel incision, it can also contribute to lateral erosion, where flow is deflected into banks, and smother aquatic habitat. Large sediment slugs are steadily filling in many of the river pools along the

Dale River (Image 6) and some of the smaller pools have already been completely filled.

## Foreshore vegetation

A healthy river system supports a diverse range of trees, shrubs, rushes, sedges and herbs. The vegetation on the banks and in the channel acts to slow water velocity and support the banks to minimise erosion. Additionally, the riparian vegetation provides habitat to a wide variety of fauna and acts as a biological filter, removing sediment and nutrients and maintaining water quality (Pen, 1999).

The foreshore and verge vegetation along the Dale River is rated as moderate in most sections, indicating that while there is relatively good vegetation cover, there is a mix of exotic and native species. A total of 62 native species and 40 introduced species of plant were identified during the survey. The list of species identified during the survey is included in Appendix 9. This list is not exhaustive and there are likely to be plant species, especially introduced species, which are present in the riparian zone but were not recorded during the survey.

The foreshore vegetation along the majority of the Dale River is dominated by an overstorey of flooded gum (*Eucalyptus rudis*), York gum (*Eucalyptus loxophelba*) and occasionally wandoo (*Eucalyptus wandoo*) with a middlestorey of swamp paperbark (*Melaleuca rhaphiophylla*). Acacia species, including jam wattle (*Acacia acuminata*), manna gum (*Acacia microbotrya*) and golden wreath wattle (*Acacia saligna*), are common. Figure 5 shows a cross section of the typical riparian vegetation along the Dale River.

*Image 6. Sediment slug smothering Reserve Pool*

Towards the headwaters of the Dale River marri (*Corymbia calophylla*) and jarrah (*Eucalyptus marginata*) are found along with mohan (*Melaleuca viminea* sub *viminea*), robin redbreast bush (*Melaleuca lateritia*) and variable-leaved hakea (*Hakea varia*) in the middle storey.

One of the species found, creeping monkey flower (*Mimulus repens*), is a Priority 3 species under the *Wildlife Conservation Act 1950*, which indicates that it is a poorly known taxa. Plant species listed under a Priority 3 conservation category are those that are known from several populations, some of which are not currently endangered, and are under consideration as rare flora but are in need of further investigation.

Agricultural weeds dominate the understorey however some native understorey species still occur including native marine couch (*Sporobolus virginicus*) and shore rush (*Juncus krausii*). Common weeds include wild oats (*Avena fatua*), soursob (*Oxalis pes-caprae*), spike rush (*Juncus acutus*), barley grass (*Hordeum leporinum*), salt-water couch (*Paspalum vaginatum*) and *Atriplex prostrata*.

These weed species have shallow root systems that lack the ability to physically bind the soil of the banks together. The dominance of weeds in the understorey therefore contributes to bank instability and erosion and sedimentation problems. Compared to when the riparian vegetation along the river was in pristine condition, the capacity of the vegetation along the main channel, and especially the tributaries, to filter sediment and nutrients has been reduced.

### Vegetation health

The riparian vegetation along the Dale River is under pressure primarily from weed invasion and stock access. In some sections, mostly those towards the headwaters, the vegetation is under pressure from waterlogging and possibly salinity. Crown decline is evident in 63% of sections, mostly among flooded gum (*Eucalyptus rudis*) but in some sections also among wandoo (*Eucalyptus wandoo*). Only 10% of sections have healthy vegetation with no evident crown decline and no dead or dying trees.

In 26% of sections there are dead trees, probably the result of waterlogging or salinity or a combination of both. However there is still enough fringing vegetation to contribute leaves and twigs to the river, which are an important source of carbon to the in-stream food web, and provide shade, which reduces water temperature and the amount of light penetration and controls the growth of aquatic plants and algae.

### Regeneration of native species

There are signs of regeneration in 70% of sections. Swamp paperbark (*Melaleuca rhaphiophylla*) (71%) and flooded gum (*Eucalyptus rudis*) (41%) are the most common species of seedlings identified. Golden wreath wattle (*Acacia saligna*) and jam wattle (*Acacia acuminata*) seedlings are found in 12% and 15% of sections respectively. In heavily grazed sections, seedlings are found on vegetated islands and sand slugs where stock access is limited.

## Habitat diversity

### Overall stream environmental health rating

Seventy-seven percent of sections have a moderate overall stream environmental health rating (OESHR) with 18% of sections rating as poor, 3% as good and 2% as excellent (Maps 8.1 and 8.2). Most of the individual categories are scored as moderate (Table 8) however the stream

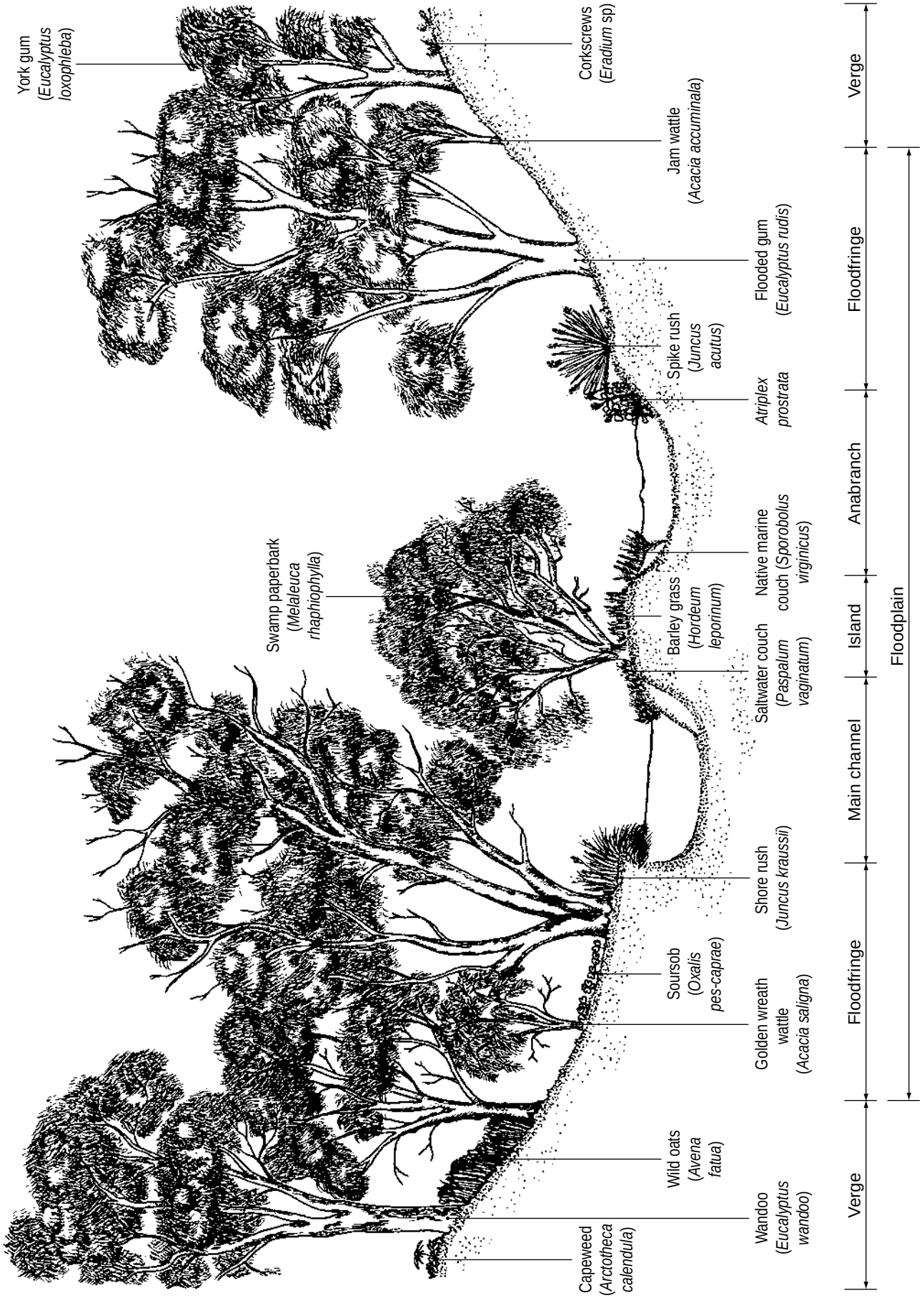



*Figure 5. Typical riparian vegetation of the Dale River (adapted from Pen, 1999 by K.Gole)*

*Table 8. Overall stream environmental health rating categories*

| Category | Percentage of sections | | | | |
|---|---|---|---|---|---|
| | Excellent | Good | Moderate | Poor | Very poor |
| Floodway and bank vegetation | | 3 | 78 | 18 | |
| Verge vegetation | | 2 | 82 | 17 | |
| Stream cover | | 35 | 53 | 12 | |
| Bank stability and sedimentation | | 8 | 73 | 18 | |
| Habitat diversity | | 38 | 55 | 7 | |

cover in 35% of sections and the habitat diversity in 38% of sections are scored as good.

## Aquatic habitat

There are a wide variety of aquatic and terrestrial habitats present along the Dale River. In terms of aquatic habitat for invertebrates, reptiles and fish:

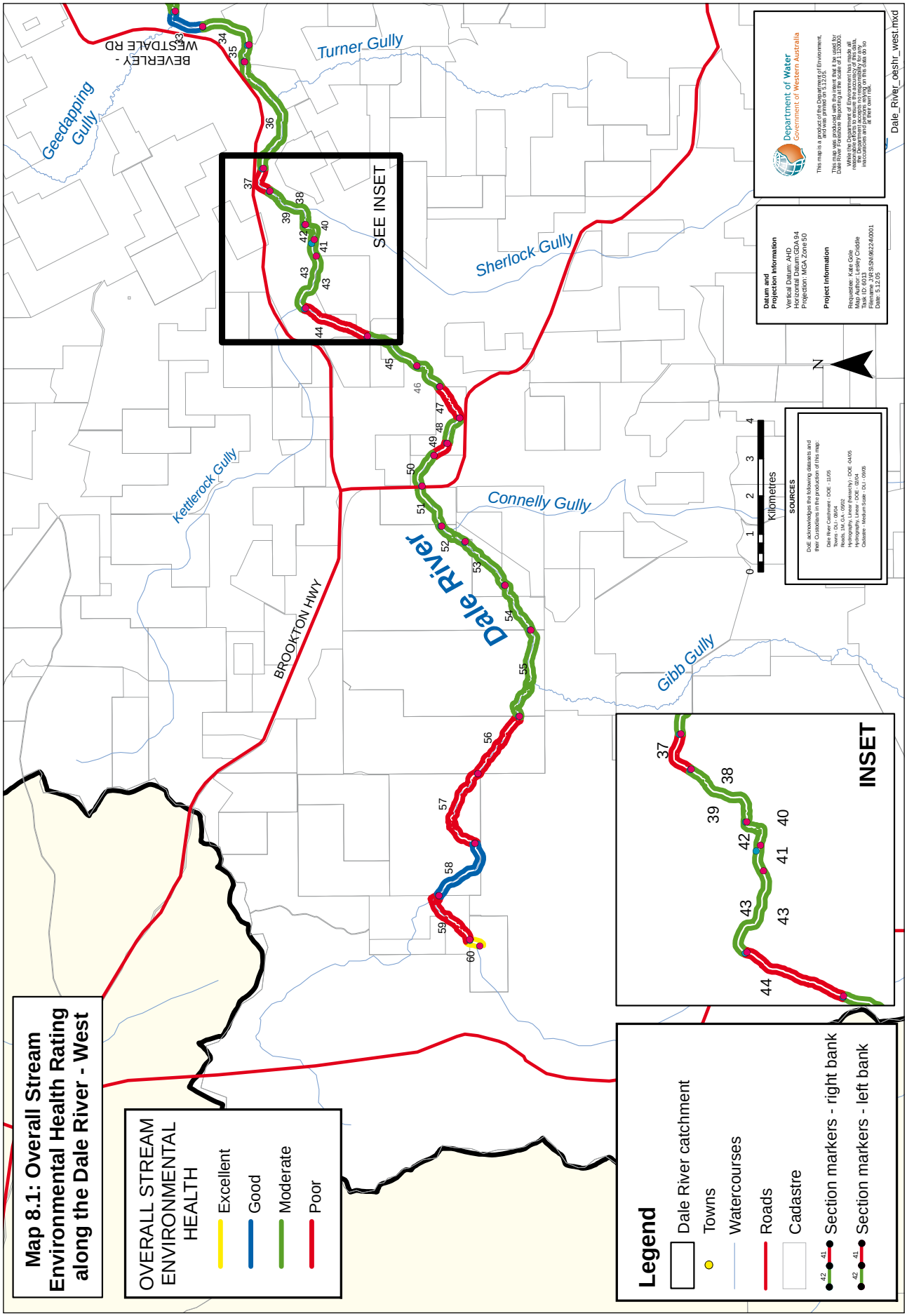
- 90% of sections have instream logs, which provide woody habitat and shelter to numerous aquatic animals;
- 75% of sections have cascades, riffles or rapids, which aerate the water, improving the quality of downstream habitats;
- 75% of sections have meanders or pools, which provide drought refuge for a range of aquatic animals, frogs and birds;
- 75% of sections have instream leaf litter, which provides cover for fish and other small animals and is an important food source;
- 28% of sections have a variety of instream and bank vegetation, which are habitat and a source food for aquatic and terrestrial animals and provide shade and a source of tannins, which lower water temperature and reduce light penetration;
- 20% of sections have instream cobbles or rocks. The hard surfaces of exposed boulders and pebbly patches in the stream bed provide essential habitat, alter the flow of water and create micro-habitats.

## Terrestrial habitat

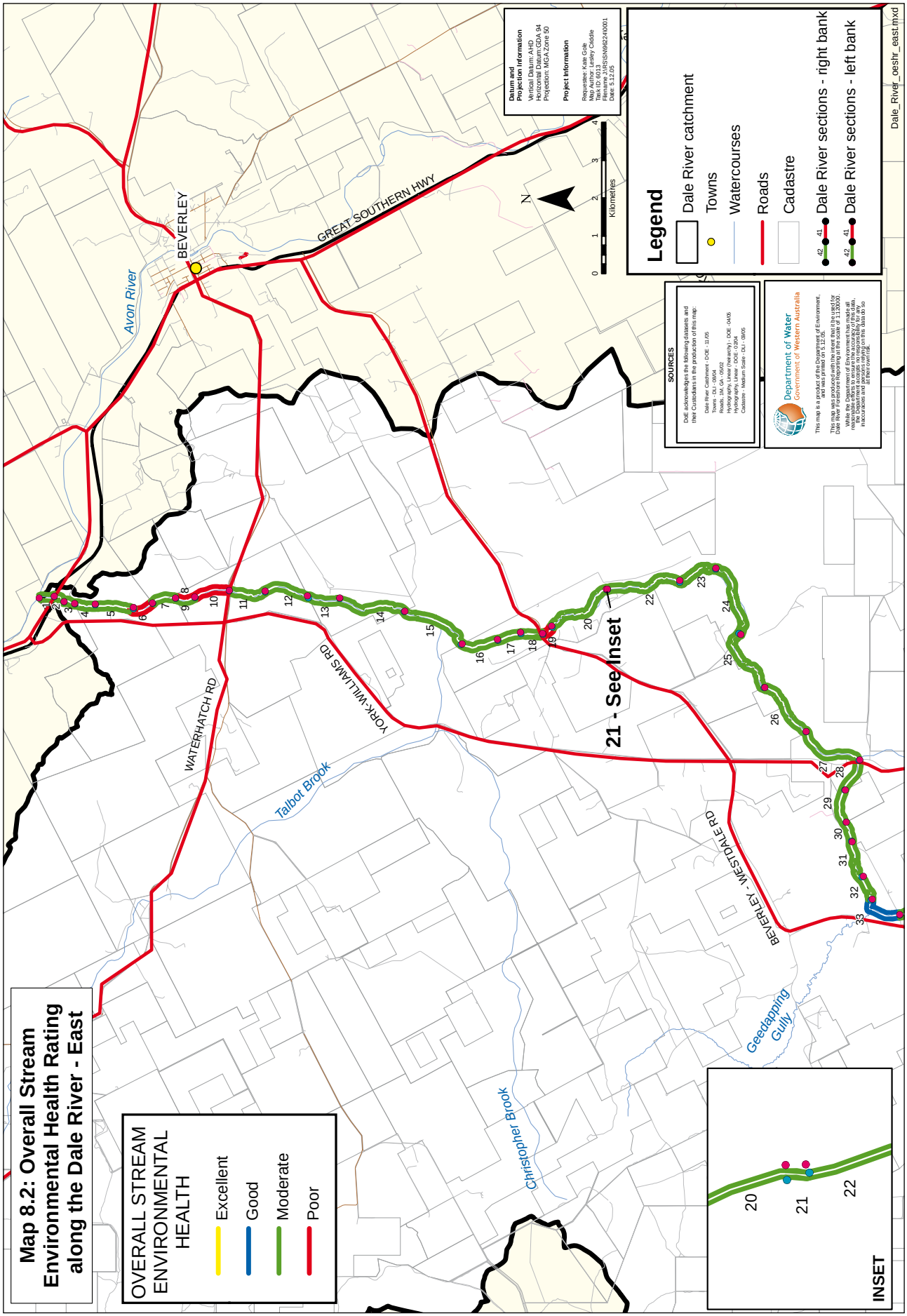
Several native fish species were identified during the survey, including western minnow (*Galaxias occidentalis*) and western hardyhead (*Leptatherine wallacei*). The introduced mosquito fish (*Gambusia holbrooki*) was also found. Long-necked tortoise (*Chelodina oblonga*) shells were found in a number of sections and sightings of live animals were made.

There is very good habitat for birds with 100% of sections having trees, 98% of sections having shrubs and 68% having rushes. A total of 57 bird species were identified during the survey (Appendix 9). The most common bird species seen during the survey included Weebill (*Smicronis brevirostris*), Australian Ringneck, commonly known as Twenty-eight Parrot, (*Barnardius zonarius*), Western Gerygone (*Gerygone fusca*), Pacific Black Duck (*Anas superciliosa*) and Grey Teal (*Anas gracilis*).

Birds classified as farmland, shrubland and woodland species were identified, indicating that birds from a variety of habitat types use the riparian zone. Farmland-classified birds found during the survey included Stubble Quail




*Map 8.1. Overall stream environmental health rating along the Dale River – West*




*Map 8.2. Overall stream environmental health rating along the Dale River – East*

(*Coturnix pectoralis*), Australia Wood Duck (*Chenonetta jubata*) and Welcome Swallow (*Hirundo neoxena*). Shrubland species included Singing Honeyeater (*Lichenostomus virescens*) and Inland Thornbill (*Acanthiza pursilla*) and woodland species included Varied Sittella (*Daphoenositta chrysoptera*), Willie Wagtail (*Rhipidura leucophrys*) and Yellow-rumped Thornbill (*Acanthiza chrysorrhoa*).

A number of the birds were classed as either priority or remnant-dependent species. Priority species have been identified as being at threat of local extinction if remnant bush is lost or degraded and included species such as Western Yellow Robin (*Eopsaltria griseogularis*), Red-capped Robin (*Petroica goodenovii*) and Rufous Whistler (*Pachycephala rufiventris*), all of which were seen during the survey. Remnant-dependent species are those likely to decline in numbers if remnant bush is lost or degrades and included birds such as Red Wattlebird (*Anthochaera carunculata*), Grey Fantail (*Rhipidura fuliginosa*) and Grey-shrike Thrush (*Colluricincla harmonica*).

There were also a number of birds seen that inhabit wetland areas such as rivers and lakes. These included Australasian Grebe (*Tachybaptus novaellandiae*), Black Swan (*Cygnus atratus*), Dusky Moorhen (*Gallinula tenebrosa*), Hardhead (*Aythya australis*), Nankeen Night Heron (*Nycticorax caledonicus*) and White-faced Heron (*Egretta novaehollandiae*).

A further twenty-three bird species have been recorded on Judy and Brent Schilling's property including Elegant Parrot (*Neophema elegans*), Western Rosella (*Platycaerus icterotis*), Sacred Kingfisher (*Halycon sancta*), New Holland Honeyeater (*Phylidonyris novaehollandiae*) and Tawny-crowned Honeyeater (*Phylidonyris melanops*) (Agriculture Western Australia, 1997). It is highly likely that some of these bird species found may utilise the riparian zone of the Dale River.

There was reasonable habitat for terrestrial invertebrates with 93% of sections having protected basking sites and 35% a variety of vegetation types. A number of insect and spider species were found during the survey including Honey bee (*Apis mellifera*), several ant and bullant species, wasp, moth and butterfly species, dragonfly species and grasshopper species.

Although only one terrestrial reptile was sighted, the Fence skink (*Acritoscincus trilineatum*), there is good habitat for reptiles including instream and bank vegetation in 32% of sections and protected basking sites in 90% of sections.

There is reasonable habitat for frogs with emergent vegetation in 47% of sections and dense streamside vegetation in 17% of sections. One frog species was heard during the survey, the Quacking Froglet (*Crinia georgiana*).

There is very little habitat for native mammals with only 7% of sections having dense, protective vegetation however two native mammals were identified during the survey including the Western Grey Kangaroo (*Macropus fuliginosus*) and Brushtail Possum (*Trichosurus vulpecula*).

A number of feral mammals were also identified including European red fox (*Vulpes vulpes*), Feral cat (*Felis catus*), Feral pig (*Sus scrofa*) and European wild rabbit (*Oryctolagus cuniculus*).

In broad terms the Dale River riparian zone is important on a local and regional scale as a provider of habitat for a wide range of fauna and as a wildlife corridor, both because of the vegetation it contains and as a link to other areas of remnant bush.

## Foreshore disturbance and management

The major disturbances observed in the foreshore and channel areas are as follows:

- 70% of sections are accessible by stock;
- 72% of sections are accessible by vehicles;
- 30% of sections have informal vehicle and stock crossings; and
- 100% of sections have weed species present.

In some sections stock are excluded from the foreshore area for the majority of the year while in others the pressure from grazing is constant. In many sections the foreshore area is an important source of green pick for stock and provides access to the river to be used as a water source. Many landholders also graze riparian areas to control weeds and therefore manage fire risk. The management of stock in the sensitive riparian area of the Dale River is a difficult balance between fulfilling these needs and minimising the damage stock are doing to the banks and remaining native vegetation.

Ninety-five percent of all sections along the Dale River have undergone some type of management. Of these sections, 98% are fully or partially fenced, 3% have undertaken firebreak control and 9% have done some revegetation within the riparian zone. The management issues that are identified as priorities include weeds, fire risk, livestock access and bank erosion (Table 9).

Table 10 sets out some general management suggestions for each overall foreshore rating. More detailed information about management issues is included in the chapter on the Principles of Waterway Management.

## Summary of main findings

The main findings from the foreshore and channel assessment of the Dale River are summarised below:

- The overall foreshore condition rating along the majority of the main channel is C-grade;
- Most of the Dale River is fenced and the majority of the fencing, being in good or moderate condition, is stock proof;
- Most of the waterway is stock and vehicle accessible;
- Undercutting and sedimentation are the main forms of bank and channel instability;
- There are a variety of waterway features and broad habitat types along the Dale River which provide habitat for a wide variety of fauna and contribute to the biodiversity value of the river on local and regional scales;
- Foreshore and verge vegetation is in reasonable condition with the overstorey and middlestorey largely intact, although the understorey is dominated by exotic species;
- The overall stream environmental health rating is moderate for the majority of sections; and
- The main management issues are stock access to the foreshore area, weeds, fire risk and bank erosion and sedimentation.

*Table 9. Priorities for management*

| Management issue | Percentage of surveyed sections | | |
|---|---|---|---|
| | High | Medium | Low |
| Weeds | 63 | 30 | 7 |
| Fire risk | 48 | 32 | 20 |
| Livestock access | 20 | 13 | 67 |
| Bank erosion | 17 | 18 | 65 |
| Sediment | 5 | 12 | 83 |
| Point source discharge | 2 | 3 | 95 |
| Pollution | 2 | | 98 |
| Rubbish | | 7 | 93 |
| Stock/vehicle crossings | | 3 | 97 |
| Feral animals | | 2 | 98 |

*Table 10. General management suggestions for each foreshore rating (adapted from Water and Rivers Commission, 2001b)*

| | |
|---|---|
| **A-grade – pristine to slightly disturbed** | A-grade foreshores require minimal management such as:<br>• Removal or realignment of large woody debris where it is causing localised erosion<br>• Removal of isolated occurrences of weeds<br>• Fence maintenance to exclude livestock<br>• Control of feral animals<br>• Establishment and maintenance of fire breaks and access tracks |
| **B-grade – weed infested to weed dominant** | Management of B-grade foreshores requires a bit more effort than for A-grade rated foreshores and includes:<br>• Removal of minor weed invasions and ongoing control of widespread weed problems<br>• Removal or realignment of large woody debris where it is causing localised erosion<br>• Manage stock access to control wed without damaging native vegetation and streambanks |
| **C-grade – erosion prone to eroded** | Management activities for C-grade foreshores are more difficult due to the higher degree of degradation however the following activities can help maintain and restore value to the river section:<br>• Use of large woody debris to protect banks from erosion<br>• Revegetation with local native species to stabilise banks and provide habitat<br>• Stabilisation of sediment slugs with local native species<br>• Management of stock access and stocking rates to jointly control widespread grassy weeds and maintain vegetation on streambanks to protect them from erosion |
| **D-grade – eroding ditch to simple drain** | It is very costly to restore D-grade foreshore areas. Priorities for management include:<br>• Revegetation in localised areas initially using fast-growing species then in-filling with slower growing plants<br>• Implementing strategies to slow water flow, for example using large woody debris and riffles<br>• Undertaking localised weed control in and around revegetation areas<br>• Managing stock access and stocking rates to jointly control widespread grassy weeds and maintain sufficient vegetation cover on streambanks to protect them from erosion |

# 5. Actions for the recovery of the Dale River

## Key issues identified for action

From consultation with the community, the foreshore and channel assessment and field inspection, a number of key issues were identified and prioritised for action. The actions for each of the issues listed below are detailed in this chapter and summarised in Table 11.

**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.**

### High priority issues

The following seven issues will be given first priority for recovery work on the Dale River:

- Protection and enhancement of water quality;
- Recovery and protection of river pools;
- Control of stream flow rates along the river channels;
- Protection and enhancement of riparian vegetation along the river and major tributaries;
- Bushfire management;
- Protection of heritage and historical sites; and
- Control of invasive and noxious weeds growing along the river.

### Medium priority issues

The following are considered also to be important issues but with secondary priority for action. Depending on availability of funds and community energy, some of these actions might run in parallel to those listed above:

- Control of feral and pest animals;
- Flora and fauna conservation;
- Management of recreational use of the river;
- General clean up of historical accumulations of agricultural and domestic rubbish;
- Mitigation of potential flood damage; and
- Management of commercial use of resources, for example sand.

### Ongoing river management

In addition to all the specific issues listed above, it is considered essential that there is an ongoing program of work continuing into the future. This will involve:

- Monitoring all environmental aspects of the river, particularly water quality;
- Reacting to emergencies (fires, chemical spills, floods etc);
- Support for community groups involved in land and rivercare;
- Community education, especially in local schools, on the value of the river and its protection; and
- Ensuring advantage is taken of opportunities presented by on-going planning processes to contribute to rivercare objectives.

## Management of water quality

**The goal:** To improve the quality of the water in the Dale River by promoting and implementing measures which reduce the inflow of pollutants and sediments to the river and which protect the sources of fresh water flowing into the river.

**Priority:** High

## Salinity and nutrients

The principal risk to water quality is salt. Although the Dale is still considered a relatively fresh river, salinity is an increasing problem. There are two main sources of salt entering the Dale. The first is the inflow from the Talbot Brook and the main gully systems in the upper catchment (Geedapping, Kettlerock, Flint and Connolly). Saline inflow from these tributaries may be balanced to some extent by fresh inflow from Christopher Brook, which dilutes the Talbot Brook just before it enters the Dale and by a number of fresh water springs along the river. A second source of salt is from saline seeps adjacent to the banks of the river. These are generally found at the foot of large cleared paddocks. They generate salt water which flows directly overland into the river.

The most appropriate and effective actions to control salinity on farmland is the subject of ongoing research and field trials. In some cases effective action on farmland (for example drainage) can lead to salt accumulating elsewhere (for example in the river). This Recovery Plan cannot require landowners to take any particular action but can provide guidance and promote financial assistance for positive works.

The other major pollution problem is organic matter and fine sediments, which carry phosphorous and nitrogen originating from stock, urban wastes and farm paddocks into the river, resulting in eutrophication and algal blooms.

Sources of fresh water flowing into the Dale are not yet clearly defined. The Christopher Brook and the deep sandy soils west of Kokeby are considered to be significant in this respect and their further study is essential.

*Action to be taken:*

Action 1.1 Areas of salinity risk within the Dale River catchment will be considered as a study area when prioritising areas under the Manage-ment Action Targets set out in the ACC Natural Resource Management (NRM) Strategy.

Action 1.2 Priority areas under the ACC NRM Strategy the following actions are recommended: support for strategic planning, funding and technical assistance for landowners and catchment groups to promote salinity control strategies.

Action 1.3 In priority areas support and funding will be given to land and river management groups set up along the main channel and tributaries of the Dale.

Action 1.4 Within priority areas land owners will be advised of the most effective approach to minimising salinity. It is expected that this approach will involve a range of measures, including:

- Minimise groundwater recharge by plant-ing deep-rooted perennial crops at key recharge sites, eg the foot of rock outcrops, sandy upland soils;
- Use shallow surface drains to shed fresh water from rocky uplands directly into streams or dams;
- Revegetate rocky uplands and manage these areas as bush, not pasture;
- Adopt farming schemes which incorporate perennial

crops, for example phase cropping with commercial trees or lucerne;

- Encourage agroforestry and commercial forestry on suitable sites;
- Restore saline lowlands by drainage and revegetation with salt-tolerant trees and shrubs; and
- Install raised bed cropping in cereal-growing areas subject to waterlogging.

Action 1.5 Funding is available for further foreshore and channel assessments of priority tributaries in the Avon Arc, which includes the Dale River catchment. An assessment of Dale River South Branch will be completed in 2006. This will complement the existing foreshore and channel assessment of Talbot Brook. Following this, Christopher Brook will be recommended as a priority tributary in this process to identify the special measures needed to protect the water quality of this important stream.

Action 1.6 Water quality in major tributaries in the Avon Catchment, including the Dale River catchment, will be monitored as part of an Avon catchment-wide water quality monitoring program.

Action 1.7 DoW will produce a map showing the principal point sources of pollution along the Dale River (for example sheep yards, piggeries, where outflow is directly entering the river or waste water/sewage from dwellings close to the river). This map will be used as a basis for progressive negotiation with landowners and the Shire to remediate the problem.

Action 1.8 The Shire of Beverley will be asked to consider the risk of potential river pollution when reviewing their Town Planning Scheme and applications for planning approval for new dwellings along the Dale floodplain.

Action 1.9 DoW will promote the need for a hydrogeological study of the deep sands east of the river and west of Mt Kokeby (Maitland Swamp) to determine their role in the hydrology of the catchment, in particular the contribution of fresh water to the Dale River.

### Sediments

There are three main sources of sediment reaching and becoming a problem in the Dale River. These are:

1. Movement of topsoil from farm paddocks into tributaries and the main channel as a result of overland flow;
2. Collapse of waterway banks which have been denuded of vegetation and trampled or broken up by stock; and
3. Wash of gravel and fine sediment from roads and road verges into waterways at bridges, culverts and rocky crossings.

One of the most serious sources of sediment is the Kettlerock Gully, which can be described as a ‘river of sand’ flowing into the Dale.

The measures needed to control sedimentation are well known and relatively simple.

*Action to be taken:*

Action 2.1 DoW will identify and maintain a database of landowners with land encompassing or bordering the main channel and major tributaries.

Action 2.2 Landowners will be encouraged to fence waterways and revegetate fenced land with local native species of the area. Stock will be excluded from riparian zones, other than in brief periods for control of bushfire fuels, as discussed below, or for entry at nominated stock watering points.

Fencing materials are currently available through the Avon Fencing Project funded through the ACC (see page 64 for more information).

Action 2.3 Working from the first and second-order streams down, landowners will be encouraged to excavate sediment 'slugs' which are choking waterways on their land using best management practice.

A permit may be required for these works and landholders are asked to contact DoW if considering works of this nature.

Action 2.4 Sediment traps will be installed on drainage lines into waterways where needed, with DoW to provide guidance on the design.

Action 2.5 As a major source of sediment to the Dale River, Kettlerock Gully will be recommended as a priority tributary for foreshore and channel assessment.

Action 2.6 Using the foreshore and channel assessment, eroding sections of the river channel will be targeted for foreshore repair and revegetation.

Action 2.7 The Shire of Beverley will be requested to review engineering and road maintenance practices on roads which cross the Dale River and its tributaries with a view to preventing erosion of road shoulders and wash of gravel and fines into waterways.

This can be accomplished by having drainage cut-offs along slopes to take the water out of table drains before they reach waterways and by installing and maintaining silt traps.

## Recovery and protection of the river pools

**The goal:** To progressively rehabilitate and protect the pools of the Dale River.

**Priority:** High

There are 25 named pools on the Dale River, and they vary in size and importance. Although all of the pools remain attractive in winter and spring after good rains and most retain a fringe of natural vegetation, they are all filled or are filling with sediment (sand and clay). Currently every pool on the Dale River is threatened with extinction. The pools are important because they represent a summer refuge for wildlife, and a source of pleasure to people who live along, or who visit the river.

The pools derive their water from two sources: river flow and inflow of groundwater. In the case of the mid-river pools (Mile, Mandiakin and Annandale) groundwater is relatively fresh, emanating

from deep sandy soils unaffected by salinity. Protection of this fresh groundwater is thus essential for the long term health of the pools.

No work has yet been done to remove sediment or to minimise sediment inflow into any Dale River pool. Techniques of pool restoration and management are still evolving and the work is expensive. It is possible in the future that the sediments will have commercial value, and excavation can be self-funding, but in the meantime other strategies must be adopted. The general process by which pool recovery is likely to be undertaken is to:

1. Nominate priority pools;
2. Develop and implement a plan for pool recovery and protection; and
3. Nominate further pools for recovery as funds become available.

Ideal pools for initial recovery works are those with easy access for vehicles and machinery that are visible to the public and where there are sympathetic landowners and neighbours who will cooperate with the project.

### *Action to be taken:*

In addition to the work on sediment management set out in Actions 2.3 and 2.4 above, the following actions will be taken:

Action 3.1 Waterhatch Pool, Mile Pool and Mandiakin Pool are nominated as 'Demonstration Pools' where, subject to available funds, a program of rehabilitation and pool protection will be undertaken.

Action 3.2 Nominated pools along the Dale River will be included in the assessment of priority pools undertaken as part of an Avon catchment-wide project to rehabilitate river pools funded through the ACC NRM Strategy and Investment Plans.

Action 3.3 When funding is available, detailed recovery and management guidelines will be developed for each priority pool in consultation with pool landholders and neighbours. This will cover removal of existing sediments and their disposal; installation of sediment traps to minimise future influx of sediments; fencing and revegetation (where needed) of the surrounding riparian zone; and subsequent monitoring and maintenance.

Action 3.4 Once the work on these pools has been successfully completed, two further pools will be nominated for the assessment process by DoE and the community.

## Controlling stream flow rates along the river channels

**The goal:** To slow the rate of stream flow along the river channels to minimise movement of sediments, erosion of stream banks and damage to streamside vegetation.

**Priority:** High

### *Action to be taken:*

Action 4.1 The foreshore and channel assessment will be used to nominate sites where log or stone 'riffles' may be effective in slowing streamflow rates.

Action 4.2 If required, riffles will be installed and maintained at these sites.

Action 4.3 DoE, in conjunction with the Shire of Beverley, will examine existing river crossings to see if they can be re-engineered to double as riffles and sediment traps.

Action 4.4 Neighbours along the river will be discouraged from 'cleaning out the river', other than removing slugs of sediment. Woody debris in the waterway (ie logs) should be retained and islands within the river revegetated.

## Protection and enhancement of riparian vegetation along the river and major tributaries

**The goal:** To protect and enhance existing riparian vegetation and encourage riparian revegetation in degraded areas.

**Priority:** High

An ideal situation is a minimum vegetation width of 100 metres (50 metres either side) for tributaries and 200 metres (100 metres either side) for the main river channel. As this would involve the revegetation of much valuable cropping land, it is unlikely to be achieved in the short term, but this should remain a long-term goal.

The riparian vegetation along the Dale and its tributaries plays many vital roles. By acting as a 'filter strip' it protects the waterways from sedimentation and pollution. It provides habitat for native fauna, and provides a corridor for the movement of fauna across the landscape. Vegetation on the banks helps to control erosion, acts as a windbreak and provides summer shade. Finally, the native bush along waterways is a beautiful and interesting element of the visual landscape.

The dominant trees of the lower Dale are flooded gum (*Eucalyptus rudis*) and swamp sheoak (*Casuarina obesa*). Higher up the river and the along the tributaries flooded gum dominates but with a middlestorey of swamp paperbark (*Melaleuca rhapiophylla*). Flooded gum is in decline in many places along the river from the combined effects of waterlogging, salinity, defoliating insects, dry seasons and exposure. Regeneration of all native species is hampered by grazing and the dominance of weeds in the understorey.

The Dale River is still used for stock watering and landowners have rights to this water under the *Rights in Water and Irrigation Act 1914*. A key requirement is to ensure stock watering but to minimise stock damage to river banks and to riparian vegetation. This can be accomplished with planned stock watering points.

### *Action to be taken:*

Action 5.1 The fencing condition map produced through the foreshore and channel assessment component of this project will be used to identify where the river is yet to be fenced or where new fences are required (refer to Map 6.1 and 6.2).

Action 5.2 Funding permitting, DoW on behalf of the ACC, will contact river neighbours where fencing is required and negotiate with them to have the waterway fenced. Under fencing agreements, stock watering points are permitted where no alternative water is available and essential farm crossings will be retained (for more information refer to Water Note 7, WRC 2000).

Action 5.3 Through fencing agreements landowners will be encouraged to 'set back' fences from the waterway, so as to achieve increased widths of riparian vegetation along both banks.

Action 5.4 Riparian areas will be retained ungrazed (apart from the need to deal with fire hazards, see Action 6.2 below).

Action 5.5 Landcare groups and neighbours will be encouraged to revegetate riparian zones within fences with appropriate native vegetation.

## Bushfire management

**The goal:** To minimise the undesirable impacts of bushfires on the riverine system, landowners and community assets.

**Priority:** High

The risk of a bushfire is ever-present in the Australian environment, due to lightning, human action and the inflammable nature of the vegetation. Infrequent low intensity fires do little permanent damage to mature bushland, but can promote weed growth in disturbed land. High intensity summer fires can kill mature trees and destroy stream-protecting vegetation and bushland fauna, and will set back regeneration work as well as encouraging weeds.

Bushfires may be hard to tackle along many sections of the Dale River because of limited access, and difficult terrain. Strong winds may turn the river into a 'wick' along which a fire will run for many kilometres before it can be controlled. Long unburnt bushland may generate 'spot fires' well ahead of the main fire, from burning bark and twigs carried aloft in the wind.

The riverine ecosystem along the Dale is particularly vulnerable to fire because in some places there is a heavy burden of annual weeds, such as wild oats, which dry out every summer. In others, where landowners have taken responsible action to fence the waterway and exclude sheep, there has been regrowth of native shrubs and small trees and accumulation of fire fuels.

### *Action to be taken:*

Action 6.1 A fire management review of the river will be undertaken each spring under the leadership of the Shire of Beverley, involving the Chief FCO and representatives from FESA, DoW and local brigades. The aim will be to highlight any specific problems which can be fixed before summer, such as dangerous power lines, washed-out crossings, high hazard sites, or problems associated with non-compliance with the Bush Fires Act which the Shire needs to enforce.

Action 6.2 Landowners who adjoin the river and main tributaries, who have a negotiated fencing agreement with DoW and who are concerned about the fire hazard along the river, may undertake crash grazing of the riverine area in spring to control annual weeds. Grazing needs to be controlled to the extent that stock are removed before they damage native vegetation.

Action 6.3 Landowners who have fenced off waterways, have a negotiated fencing agreement with DoW and are concerned

about bushland fuels may undertake a cool burn for fuel reduction purposes if this is part of the negotiated agreement. Burns should be no less than 8–12 years apart.

## Protection of heritage and historical sites

**The goal:** To protect heritage and historical sites (both indigenous and European) and aspects of importance to Noonygar people along the Dale River.

**Priority:** High

It is recognised that the local Noonygar people have important associations with the river, and that there are sites which must be protected from unwitting damage. No attempt has been made as part of this plan to identify specific sites, the location of which is not normally made public. Nonetheless, their presence and importance is acknowledged.

In addition there are many sites of importance to European settlers along or close to the river which need to be identified and looked after. These include old homesteads, bridges, crossings, survey markers, fences etc.

### *Action to be taken:*

Action 7.1 Organisations and individuals undertaking restoration works within the Dale River catchment need to consult the State's Heritage Register before work is commenced to determine whether there are any registered sites along the river, and to ensure these are protected from impact of recovery work.

Action 7.2 Organisations and individuals undertaking restoration works within the Dale River catchment need to consult with Noonygar Elders of the Beverley/Dale area before any potentially site-disturbing work is undertaken along the river. Elders will be given the opportunity to advise whether proposed work represents a threat to sites or values and to help design projects so as to avoid problems.

Action 7.3 DoW will request access to the Shire of Beverley's register of historical sites and ensure that relevant information arising from this River Recovery Plan is included.

## Control of invasive and noxious weeds

**The goal:** To commence control of the most serious weeds within riparian vegetation along the river and main tributaries.

**Priority:** High

This is a daunting task. Nevertheless weeds degrade bushlands and waterways, increase vulnerability to fire and prevent the regeneration of native species. In some cases (eg bridal creeper) they have the potential to completely take over a bushland area. Other weeds present along the river are one-leaf cape tulip (*Homeria flaccida*), doublegee (*Emex australis*), calthrop (*Tribulus terrestris*), dock (*Rumex* spp) and wild oats (*Avena fatua*). All of these species are favoured by frequent fire, but most can be shaded out by a good tree canopy.

In the initial phase of implementing this Recovery Plan two strategies are recommended for weed management:

1. Protection and rehabilitation of native riparian vegetation. This will lead to a

healthier overstorey of flooded gum and swamp sheoak, and this will help to shade out many weed species; and

2. A 'localised response' approach will be taken to any serious outbreak of a particular weed, where infestations will be treated at a local level.

*Action to be taken:*

Action 8.1 Landowners are encouraged to report any serious infestations of invasive weeds in the riparian zone to DoW and DAWA and seek advice on weed control.

Action 8.2 Neighbours will be encouraged to control serious weeds along the river adjoining or within their own properties.

Action 8.3 Where opportunities exist, project teams (eg Green Corps, prisoner work parties) will be organised to work on weed problems along the Dale.

## Control of feral animals and pest species

**The goal:** To control populations of feral animals that are a nuisance or predate native fauna.

**Priority:** Medium

The three principal feral animals of concern along the Dale River are the European fox and feral cat, which predate native fauna, and rabbits, which browse riparian vegetation. Controlling foxes and cats will lead to a gradual recovery of native water rats, some species of small marsupial and birds, and in addition will benefit sheep farmers adjoining the river. Control of rabbits will assist with recovery of the bushland.

Control of feral cats is extremely difficult, and as yet no effective means has been developed. However, both fox and rabbit control measures are available. The most effective methods involve the use of poison baits, plus opportunistic shooting. For the best benefit to the river it is necessary to organise planned cooperative programs involving many landowners along specific river sections.

Landholders have reported feral pig activity at several sites along the Dale River. Pigs are extremely damaging animals in a riverine situation, because of the way they root up the soil and destroy vegetation.

*Action to be taken:*

Action 9.1 Sightings of feral pigs should be reported to DAWA for advice on their control.

Action 9.2 Landowners along the river will be asked to develop annual cooperative feral animal control programs.

Action 9.3 DoW will liaise with the DAWA and CALM for the latest information on feral animal control.

There have been reports of a rapid expansion of kangaroo numbers along some sections of the Dale in recent years. High kangaroo numbers can increase grazing pressure on riparian vegetation and damage fences and neighbouring farmland. In the event of kangaroos becoming a problem for the river or for river neighbours, it may be necessary to cull some animals. Kangaroo problems should be referred to CALM for their advice on the best approach.

## Fauna and flora conservation

**The goal:** To determine whether there are any special species of plant or animal found along the Dale River, and if there are to ensure their protection. An additional aim is to ensure linkages for fauna, through protection of the riverine ecosystem along its entire length, and protection of riparian vegetation along tributaries, which provide corridors for bird and animal movement.

**Priority:** Medium

The native water rat (*Hydromys chrysogaster*) was once common along the Dale, but has disappeared in the last 25 years. It still occurs in small populations along the Avon, and could move back to the Dale if foxes and feral cats were controlled and there was suitable habitat available. The Long-necked Tortoise (*Chelodina oblonga*) has been sighted in a number of places along the Dale River by landholders and during the foreshore and channel assessment.

Vegetation communities associated with some of the river pools have been listed under CALM's Priority Ecological Communities list. Priority Ecological Communities do not meet the criteria to be listed as Threatened Ecological Communities, which are protected under the *Wildlife Conservation Act 1950*, but are still recognised as important.

While there are no designated occurrences of Declared Rare flora or fauna along the river, creeping monkey flower (*Mimulus repens*), which is a Priority 3 species under the *Wildlife Conservation Act 1950*, was found in several sections during the foreshore and channel assessment.

### *Action to be taken:*

Action 10.1 DoW will support efforts to seek funding for a biological survey of the river, through liaison with CALM, WWF and the Beverley Naturalists' Club, to be undertaken progressively over several years.

Action 10.2 High priority will be given to fencing and revegetating (where necessary) riparian strips which can provide corridors to link reserves and other patches of remnant bushland.

Action 10.3 Actions listed elsewhere in this plan to minimise salinity in the Dale will be taken in the additional interests of native fauna and flora.

## Managing recreational use of the river

**The goal:** To ensure that recreational use of the river does not damage the riverine environment or become a nuisance for riverside neighbours.

**Priority:** Medium

There are no developed public recreation sites along the Dale River at present. As most of the environs of the Dale River are private property, this is not likely to change and no new public developments are suggested in this plan. Current recreational use is mostly passive, for example, walking, appreciation of nature and some minor boating on the larger pools when they are full from mid-winter to early-summer.

There is a risk of damage to the riverine environment from some recreational activities, such as off-road driving, trail bikes and horses along the banks of the river or use of high powered boats in the pools or along the river channels.

This Recovery Plan does not recommend the development of any new recreational

facilities along the Dale River. The emphasis is on managing existing recreational use.

*Action to be taken:*

Action 11.1 DoW will encourage landowners to care for the riverine environment by minimising recreational use which will degrade the vegetation or river banks.

Action 11.2 Landowners along the river will be asked to report unacceptable recreational use to the appropriate authorities so that action can be taken to control it.

## General clean up of historical accumulations of agricultural and domestic rubbish

**The goal:** To rid the riverine environment of rubbish dumps and to discourage rubbish dumping along the river in the future.

**Priority:** Medium

The foreshore and channel assessment revealed a number of old rubbish piles, mostly agricultural junk or waste products, along the river. These are unsightly, and in some cases (for example accumulations of used herbicide containers or household garbage) may cause future pollution.
In many cases the rubbish is 'historical' and was not placed there by the current landowner.

*Action to be taken:*

Action 12.1 From the results of the foreshore and channel assessment a map will be prepared showing the location of existing rubbish dumps along the river.

Action 12.2 DoW in conjunction with the Shire of Beverley will promote the removal of rubbish from foreshore areas.

Action 12.3 Landowners will be requested not to dispose of rubbish in or along the river.

## Mitigating potential flood damage

**The goal:** To minimise potential flood damage to farmland or residences along the river.

**Priority:** Medium

Flooding has not been a problem along the Dale for decades. This is due to a number of factors, but mostly to below-average rainfall since the 1970s. On the other hand, the risk of flooding following heavy rainfall events has increased in recent years due to both the increase in surface runoff as a result of widespread land clearing and the sedimentation of river pools.

*Action to be taken:*

Action 13.1 Sediment management, river flow-rate reduction and pool recovery programs, as discussed earlier in this plan, will be adopted.

Action 13.2 The Shire of Beverley will be advised of the increased risk, and a recommendation made that no new buildings be approved on flood-susceptible land adjacent to the river.

## Managing commercial use of resources

**The goal:** To channel any funds from resource-use back into river recovery.

**Priority:** Medium

The most likely commercial product that could be derived from the river is the sediment filling the pools and channels of the river. This sediment is owned by the landowner if they own the land 'under the water' or by the crown in the case of a pool or river section adjoining crown land. This issue is being addressed in the current round of funding through a project funded through the ACC NRM Strategy where sediment management plans will be written for priority pools throughout the Avon Catchment.

A permit may be required to extract sediment if a private business or individual undertakes the process. Landholders are encouraged to contact DoW if they are planning to undertake sediment removal works. River sediment is becoming valuable as building base and fill in the Avon Valley and the metropolitan area. It is desirable to find a market for this material to underwrite the cost of its removal from the pools.

Other potentially commercial products such as gravel, timber, firewood, wildflowers, seeds, and kangaroos occur in bushland along the river. This River Recovery Plan does not recommend that these products be utilised.

### *Action to be taken:*

Action 14.1 DoW, through the ACC Investment Plan, will continue to look for markets for river sediments and when these are found, will seek to direct them to landowners adjoining the pools on the Dale River.

Action 14.2 DoW will assist landowners to negotiate with sediment buyers.

Action 14.3 Landowners will be discouraged from commercial operations utilising the natural resources of the riverine area.

## Water extraction

**Goal:** Increase understanding of groundwater interactions in the area west of Kokeby

**Priority:** Medium

Fresh groundwater is a very important resource within the catchment with respect to the health of the river environment.

There may be proposals in the future to develop bores to fresh water aquifers within the catchment, in particular the good quality water within deep sandy soils west of Kokeby. To date there has been little study of these aquifers, for example definition of their extent, whether or not they are confined and the extent to which they contribute fresh water to the river, especially the pools.

The DoW may require a proponent to undertake hydrological studies to determine the sustainability of proposals to commercially extract groundwater and the effect of potential proposals on the river and groundwater-fed river pools.

## Ongoing river management

There are a number of aspects of river management which need to be on-going in the years ahead and which will involve partnerships between stakeholders including DoW, ACC, Shire of Beverley, CALM, DAWA and landowners.

Where possible DoW will make resources available and will support landowners and land and river management groups along the Dale and its tributaries.

The key aspects of ongoing management are:

1. **Monitoring**. There are a wide range of factors which could be monitored, but the amount of monitoring is constrained by funding and human resources. The most important aspect in the short term

is water quality (especially salinity and organic pollution) as this data will be a primary indicator of river health.

2. **Emergency response**. It is critically important that the community can react quickly and effectively to calamities such as bushfire, chemical spills or accidents in or along the river. There are existing emergency plans, developed by FESA and the Shire, and these will be supported wherever necessary as a part of river management.
3. **Supporting community groups**. DoW will support community groups involved in landcare or conservation for work in and along the river. This will take the form of direct funding (if available), technical advice and support for grant applications.
4. **Community education**. DoW, through the ACC, will undertake community education programs in the West Dale and Beverley areas to help people value and recover the river.

## Managing land use change

Land use change, in particular subdivision or amalgamation of properties or updating of the Shire of Beverley's Town Planning Scheme No. 2, provide on-going opportunities to consider the benefits to river conservation. This will require liaison between agencies and the Shire of Beverley. Opportunities to consider will include:

- Establishing a foreshore reserve along the river, vested in the Crown;
- Negotiating property boundaries to be set back from the river to allow wider revegetation of riparian zones; and
- Creating new reserves adjacent to river pools where conservation programs can be implemented.

DoW will confer with the Shire of Beverley and seek an agreement on priorities for opportunistic changes to riparian zones along the Dale and its major tributaries.

## Implementation

Implementation of this River Recovery Plan will involve the expenditure of many millions of dollars over many years. This represents a major investment in the Dale region and its community. It is essential that this investment is well managed – in other words according to agreed priorities, and with effective monitoring of expenditure and measurement of benefits.

The ACC is the peak regional NRM body in the Avon Region and establishes priorities for funding projects to improve resource condition in the Avon River Basin.

Together with its stakeholders the ACC has overall responsibility for the implementation of the priorities in this River Recovery Plan. Future works in the Dale River catchment will primarily be delivered through the ACC NRM Strategy and current and future Investment Plans through partnerships between their delivery organisation DoW, Shire of Beverley, CALM, DAWA and landowners. Additional funding may be sourced as required.

This River Recovery Plan recommends seeking funding to resource implementation of recovery actions set out above and summarised in Table 11.

### Partnerships with the Avon Catchment Council

The River Recovery Plan for the Dale River has been funded through the ACC NRM Strategy and Investment Plans and DoW will ensure that the ACC is aware of the funding implications of implementing this plan.

### Working with research organisations and other agencies

ACC and DoE will establish linkages with appropriate research organisations including the CSIRO and universities and will promote studies into the river and its recovery. A priority will be given to economic research which seeks to quantify the cost/benefit to landowners and the wider community of investment in the Dale River recovery program.

Close liaison will also be developed with CALM regarding the protection and recovery of the river pools.

### Working with landowners who adjoin the river and major tributaries

In addition to traditional activities such as providing fencing and assistance with river restoration projects, ACC and DoW will examine innovative approaches, which focus not so much on 'providing a grant' but in the 'purchase of environmental benefits'. An example of this approach would be to:

- Nominate a section or stretch of the river, or a specific pool;
- Prepare a set of detailed specifications for work along that section, arising out of the Recovery Plan;
- Call for tenders for the work; and
- Oversee the job and pay the contractors.

The ideal way this approach could be implemented would be through the awarding of the contract to local landowners working on their own properties, in some cases in a partnership with the Shire.

### Working with planning authorities

An important role for DoE and the ACC will be to work with bodies responsible for land use planning along the river. In the Dale River catchment these are the:

- Shire of Beverley, with their key planning instrument being the Shire of Beverley Town Planning Scheme No. 2 and subsequent schemes; and
- WAPC who approve Town Planning Schemes (TPS) submitted by local authorities on the advice of the Department of Planning and Infrastructure.

In revising the TPS, the Shire of Beverley should take into account the content of relevant planning documents published by the WAPC. These are the Environment and Natural Resources Statement of Planning Policy, the Draft Water Resources Statement of Planning Policy and the Avon Arc Sub-regional Strategy.

DoE and ACC will liaise with the Shire of Beverley and the planning authorities in ensuring that the TPS supports good outcomes for the river by aligning the TPS with the relevant waterways protection requirements set out in these documents.

### Working with industry

This plan provides a number of opportunities for industry and river management to develop mutually beneficial projects. For example:

- The farming industry can promote and adopt more sustainable farming systems which lead to improved soil conservation and less off-farm movement of salt, fertilisers and organic matter;
- The forestry and plantation industry can expand the plantation resource in the area, thus protecting groundwater resources, fighting salinity and stabilising soils;
- The mining industry can extract building materials from sediments in the pools and river channels; and

- The tourism industry can provide visitors with interpretative material thus helping them to understand and support river recovery work.

An important role for the ACC and DoW will be to encourage and find ways to facilitate these win-win relationships.

*Table 11. Summary of River Recovery actions*

| Action | Priority | Responsibility | Notes |
|---|---|---|---|
| **1. Water quality: salinity and nutrients** | **High** | | |
| **Action 1.1:** Areas of salinity risk within the Dale River catchment will be considered as a study area when prioritising areas under the Management Action Targets set out in the ACC Natural Resource Management (NRM) Strategy. | | DoW, ACC | |
| **Action 1.2:** Priority areas under the ACC NRM Strategy the following actions are recommended: support for strategic planning, funding and technical assistance for landowners and catchment groups to promote salinity control strategies. | | DoW, ACC | |
| **Action 1.3:** In priority areas support and funding will be given to land and river management groups set up along the main channel and tributaries of the Dale. | | ACC, DoW | |
| **Action 1.4:** Within priority areas land owners will be advised of the most effective approach to minimising salinity. | | DoW, ACC, DAWA | |
| **Action 1.6:** Water quality in major tributaries in the Avon Catchment, including the Dale River catchment, will be monitored as part of an Avon catchment-wide water quality monitoring program. | | DoW, ACC | |
| **Action 1.6:** An assessment of Dale River South Branch will be completed in 2006. Following this, Christopher Brook will be recommended as a priority tributary in this process to identify the special measures needed to protect the water quality of this important stream. | | DoW, ACC | |
| **Action 1.7:** DoW will produce a map showing the principal point sources of pollution along the Dale River to be used as a basis for progressive negotiation with landowners and the Shire of Beverley to remediate the problem. | | DoW, SoB | |

*Summary of River Recovery actions continued overleaf…*

*Summary of River Recovery actions continued…*

| Action | Priority | Responsibility | Notes |
|---|---|---|---|
| **Action 1.8:** The Shire of Beverley will be asked to consider the risk of potential river pollution when reviewing their Town Planning Scheme and applications for planning approval for new dwellings along the Dale floodplain. | | DoW, SoB | |
| **Action 1.9:** DoW will promote the need for a hydrogeological study of the deep sands east of the river and west of Mt Kokeby (Maitland Swamp) to determine their role in the hydrology of the catchment, in particular the contribution of fresh water to the Dale River. | | DoW, ACC | |
| **2. Water quality: sediment** | **High** | | |
| **Action 2.1:** DoW will identify and maintain a database of landowners with land encompassing or bordering the main channel and major tributaries. | | DoW | |
| **Action 2.2:** Landowners will be encouraged to fence waterways and revegetate fenced land with local native species of the area. Stock will be excluded from riparian zones, other than in brief periods for control of bushfire fuels, as discussed below, or for entry at nominated stock watering points. | | DoW, ACC, LH | Fencing materials are currently available through the Avon Fencing Program funded through the ACC (see page 66 for more information). |
| **Action 2.3:** Working from the first and second-order streams down, landowners will be encouraged to excavate sediment ‘slugs’ which are choking waterways on their land using best management practice. | | DoW, ACC, LH | A permit may be required for these works and landholders are asked to contact DoW if considering works of this nature. |
| **Action 2.4:** Sediment traps will be installed on drainage lines into waterways where needed, with DoW to provide guidance on the design. | | DoW, ACC, LH | |
| **Action 2.5:** As a major source of sediment to the Dale River, Kettlerock Gully will be recommended as a priority tributary for foreshore and channel assessment. | | DoW, ACC | |
| **Action 2.6:** Using the foreshore and channel assessment, eroding sections of the river channel will be targeted for foreshore repair and revegetation. | | DoW, ACC, LH | |
| **Action 2.7:** The Shire of Beverley will be requested to review engineering and road maintenance practices on roads which cross the Dale River and its tributaries with a view to preventing erosion of road shoulders and wash of gravel and fines into waterways. | | SoB | |

*Summary of River Recovery actions continued overleaf…*

*Summary of River Recovery actions continued…*

| Action | Priority | Responsibility | Notes |
|---|---|---|---|
| **3. Recovery of river pools** | **High** | | |
| **Action 3.1:** Waterhatch Pool, Mile Pool and Mandiakin Pool are nominated as 'Demonstration Pools' where, subject to available funds, a program of rehabilitation and pool protection will be undertaken. | | DoW, Dale community | |
| **Action 3.2:** Nominated pools along the Dale River will be included in the assessment of priority pools undertaken as part of an Avon catchment-wide project to rehabilitate river pools funded through the ACC NRM Strategy and Investment Plans. | | DoW, ACC | |
| **Action 3.3:** When funding is available, detailed recovery and management guidelines will be developed for each priority pool in consultation with pool landholders and neighbours. This will cover removal of existing sediments and their disposal; installation of sediment traps to minimise future influx of sediments; fencing and revegetation (where needed) of the surrounding riparian zone; and subsequent monitoring and maintenance. | | DoW, ACC, LH, CALM | |
| **Action 3.4:** Once the work on these pools has been successfully completed, two further pools will be nominated for the assessment process by DoW and the community. | | DoW, Dale community | |
| **4. Control of stream flow rates** | **High** | | |
| **Action 4.1:** The foreshore and channel assessment will be used to nominate sites where log or stone 'riffles' may be effective in slowing streamflow rates. | | DoW, ACC | |
| **Action 4.2:** If required, riffles will be installed and maintained at these sites. | | DoW, ACC | |
| **Action 4.3:** DoW, in conjunction with the Shire of Beverley, will examine existing river crossings to see if they can be re-engineered to double as riffles and sediment traps. | | DoW, SoB | |
| **Action 4.4:** Neighbours along the river will be discouraged from 'cleaning out the river', other than removing slugs of sediment. Woody debris in the waterway (ie logs) should be retained and islands within the river revegetated. | | DoW | |

*Summary of River Recovery actions continued overleaf…*

*Summary of River Recovery actions continued…*

| Action | Priority | Responsibility | Notes |
|---|---|---|---|
| **5. Protection of riparian vegetation** | **High** | | |
| **Action 5.1:** The fencing condition map produced through the foreshore and channel assessment component of this project will be used to identify where river is yet to be fenced or where new fences are required (refer to Map 6). | | DoW | |
| **Action 5.2:** Funding permitting, DoW on behalf of the ACC, will contact river neighbours where fencing is required and negotiate with them to have the waterway fenced. Under fencing agreements, stock watering points are permitted where no alternative water is available and essential farm crossings will be retained. | | DoW, ACC | |
| **Action 5.3:** Through fencing agreements landowners will be encouraged to 'set back' fences from the waterway, so as to achieve increased widths of riparian vegetation along both banks. | | DoW, LH | |
| **Action 5.4:** Riparian areas will be retained ungrazed (apart from the need to deal with fire hazards, see Action 6.2 below). | | LH | |
| **Action 5.5:** Landcare groups and neighbours will be encouraged to revegetate riparian zones within fences with appropriate native vegetation. | | DoW, ACC, LH | |
| **6. Bushfire management** | **High** | | |
| **Action 6.1:** A fire management review of the river will be undertaken each spring under the leadership of the Shire of Beverley, involving the Chief FCO and representatives from FESA, DoW and local brigades. The aim will be to highlight any specific problems which can be fixed before summer, such as dangerous power lines, washed-out crossings, high hazard sites, or problems associated with non-compliance with the *Bush Fires Act* which the Shire needs to enforce. | | SoB, FESA, DoW | |
| **Action 6.2:** Landowners who adjoin the river and main tributaries, who have a negotiated fencing agreement with DoW and who are concerned about the fire hazard along the river, may undertake crash grazing of the riverine area in spring to control annual weeds. | | LH | Grazing needs to be controlled to the extent that stock are removed before they damage native vegetation. |

*Summary of River Recovery actions continued overleaf…*

*Summary of River Recovery actions continued…*

| Action | Priority | Responsibility | Notes |
|---|---|---|---|
| **Action 6.3:** Landowners who have fenced off waterways, have a negotiated fencing agreement with DoW and are concerned about bushland fuels may undertake a cool prescribed burn for fuel reduction purposes if this is part of the negotiated agreement. | | LH | Burns should be no less than 8–12 years apart. |
| **7. Protection of heritage and historical sites** | **High** | | |
| **Action 7.1:** Organisations and individuals undertaking restoration works within the Dale River catchment need to consult the State's Heritage Register before work is commenced to determine whether there are any registered sites along the river, and to ensure these are protected from impact of recovery work. | | Any organisation or individual undertaking river restoration activities | |
| **Action 7.2:** Organisations and individuals undertaking restoration works within the Dale River catchment need to consult with Noonygar Elders of the Beverley/Dale area before any potentially site-disturbing work is undertaken along the river. Elders will be given the opportunity to advise whether proposed work represents a threat to sites or values and to help design projects so as to avoid problems. | | Any organisation or individual undertaking river restoration activities | |
| **Action 7.3:** DoW will request access to the Shire of Beverley's register of historical sites and ensure that relevant information arising from this River Recovery Plan is included. | | DoW, SoB | |
| **8. Control of invasive weeds** | **High** | | |
| **Action 8.1:** Landowners are encouraged to report any serious infestations of invasive weeds in the riparian zone to DoW and DAWA and seek advice on weed control. | | DoW, DAWA, LH | |
| **Action 8.2:** Neighbours will be encouraged to control serious weeds along the river adjoining or within their own properties. | | LH | |
| **Action 8.3:** Where opportunities exist, project teams (eg Green Corps, prisoner work parties) will be organised to work on weed problems along the Dale. | | DoW | |
| **9. Control of feral animals and pest species** | **Medium** | | |
| **Action 9.1:** Sightings of feral pigs should be reported to DAWA for advice on their control. | | LH | |

*Summary of River Recovery actions continued overleaf…*

*Summary of River Recovery actions continued…*

| Action | Priority | Responsibility | Notes |
|---|---|---|---|
| **Action 9.2:** Landowners along the river will be asked to develop annual cooperative feral animal control programs. | | LH | |
| **Action 9.3:** DoW will liaise with the DAWA and CALM for the latest information on feral animal control. | | DoW, DAWA, CALM | |
| **10. Flora and fauna conservation** | **Medium** | | |
| **Action 10.1:** DoW will support efforts to seek funding for a biological survey of the river, through liaison with CALM, WWF and the Beverley Naturalists' Club, to be undertaken progressively over several years. | | DoW, CALM, WWF, ACC, BNC | |
| **Action 10.2:** High priority will be given to fencing and revegetating (where necessary) riparian strips which can provide corridors to link reserves and other patches of remnant bushland. | | DoW, ACC | |
| **Action 10.3:** Actions listed elsewhere in this plan to minimise salinity in the Dale will be taken in the additional interests of native fauna and flora. | | | |
| **11. Managing recreational use** | **Medium** | | |
| **Action 11.1:** DoW will encourage landowners to care for the riverine environment by minimising recreational use which will degrade the vegetation or river banks. | | DoW, LH | |
| **Action 11.2:** Landowners along the river will be asked to report unacceptable recreational use to the appropriate authorities so that action can be taken to control it. | | LH | |
| **12. Clean up of domestic and agricultural rubbish** | **Medium** | | |
| **Action 12.1:** From the results of the foreshore and channel assessment a map will be prepared showing the location of existing rubbish dumps along the river. | | DoW | |
| **Action 12.2:** DoW in conjunction with the Shire of Beverley will promote the removal of rubbish from foreshore areas. | | DoW, SoB | |
| **Action 12.3:** Landowners will be requested not to dispose of rubbish in or along the river. | | LH | |

*Summary of River Recovery actions continued overleaf…*

*Summary of River Recovery actions continued…*

| Action | Priority | Responsibility | Notes |
|---|---|---|---|
| **13. Mitigating potential flood damage** | **Medium** | | |
| **Action 13.1:** Sediment management, river flow-rate reduction and pool recovery programs, as discussed earlier in this plan, will be adopted. | | | |
| **Action 13.2:** The Shire of Beverley will be advised of the increased risk, and a recommendation made that no new buildings be approved on flood-susceptible land adjacent to the river. | | DoW, SoB | |
| **14. Managing commercial use of resources** | **Medium** | | |
| **Action 14.1:** DoW, through the ACC Investment Plan, will continue to look for markets for river sediments and when these are found, will seek to direct them to landowners adjoining the pools on the Dale River. | | DoW, ACC | |
| **Action 14.2:** DoW will assist landowners to negotiate with sediment buyers. | | DoE | |
| **Action 14.3:** Landowners will be discouraged from commercial operations utilising the natural resources of the riverine area. | | LH | |

**Abbreviations**

| | |
|---|---|
| ACC | Avon Catchment Council |
| BNC | Beverley Naturalists Club |
| CALM | Department of Conservation and Land Management |
| DAWA | Department of Agriculture Western Australia |
| DoW | Department of Water |
| FESA | Fire and Emergency Services Authority of Western Australia |
| LH | Landholders |
| NRM | Natural Resource Management |
| SoB | Shire of Beverley |

# 6. Summary

The Dale River is unique in that is one of the last relatively fresh tributaries in the Avon River catchment. Never subjected to 'river training' like the Avon River, the basic structure of river pools linked by braided channels is still intact. However the Dale is degrading. The deep river pools, valued for recreation as a wildlife haven during drought, are smothering in sediment carried into the river from surrounding paddocks and eroding banks. The health of the fringing vegetation is declining due to stock grazing, weed invasion and salinity. Hence, there is a need to develop a new, shared, positive and achievable vision for the Dale River and formulate actions to recover the health of the river.

The vision for the Dale River in 20 years time is that:

- The Dale River and its tributaries will be a focus of care and responsible management in the local community, assisted by government;
- The Dale will continue to be major source of relatively fresh water flowing into the Avon River;
- The restoration of pools along the Dale will have been commenced;
- The whole of the main river channel will be fenced to allow control of grazing animals and regeneration of natural riparian vegetation;
- The tributaries flowing into the Dale will be fenced to permit stock management and revegetated to protect them from erosion, sedimentation and pollution;
- Land management and farming practices will have been adopted throughout the catchment which minimise the flow of saline water and sediments into tributaries and the Dale River;
- Important heritage sites will have been identified and protected;
- Vegetation corridors will have been established, or existing corridors protected and enhanced, to provide linkages between the river and bushland areas in the catchment;
- A program of local seed collection will have produced a seedbank, ensuring revegetation with local provenance;
- Bushfire management programs will have been developed and implemented to prevent wildfires along the river and revegetation areas, while ensuring bushland values are retained;
- Ongoing programs will continue to minimise the occurrence of serious invasive weeds and pests such as rabbits, foxes and feral cats along the river;
- The river will be free of rubbish; and
- People enjoying the river for recreation will do so without damaging the riverine environment, and without causing problems to landowners along the river.

To this end a number of actions have been set out in this River Recovery Plan. The following six issues will be given first priority for recovery work on the Dale River:

- Protection and enhancement of water quality;
- Recovery and protection of river pools;
- Control of stream flow rates along the river channels;
- Protection and enhancement of riparian vegetation along the River and major tributaries;
- Bushfire management; and
- Protection of heritage and historical sites.

# 7. Principles for waterway management

This section provides an overview of riparian management issues relevant to the Dale River and details of where further information can be found. It is intended as a guide for anyone undertaking river management activities. Included is a recommended reference list for landholders, many of which can be obtained from DoW in Northam by calling (08) 9622 7055.

## Land tenure and riparian rights

The land tenure of the Dale River riparian zone varies. The majority is privately owned but some is vested in the Crown. Some foreshore reserves along the Dale River are vested in the Water and Rivers Commission (now DoW) and the Shire of Beverley. Any activities or works within these foreshore reserves requires authorisation from the management body.

The law relating to rights to surface water is contained in the *Rights in Water and Irrigation Act 1914* (*RIWI Act*). The DoW has licensing and control powers over wetlands and watercourses in proclaimed areas. The Dale River catchment is located within an area that is proclaimed under the Act.

Landowners who have access to the Dale River have riparian rights which allow the extraction of water from the river for stock and domestic purposes, however taking water in excess of riparian rights (ie for commercial purposes) may require a licence.

DoW encourages owners of properties adjacent to waterways to adopt a stewardship role to protect these precious water resources and recognise the rights of downstream users.

Further information regarding the riparian rights and the *RIWI Act* can be obtained from the DoW in Northam on 9622 7055 or on the Department website <http://www.environment.wa.gov.au>.

## Weed control

As with many other rivers in the south-west of Western Australia, weeds are a significant management problem along the length of the Dale River. Environmental weeds pose a threat to the integrity of native vegetation, can increase fire risk and reduce the ability of native vegetation to regenerate. The presence of weeds also affects the habitat and food sources available for native fauna, both aquatic and terrestrial. The overall result of weed invasion is degradation and, eventually, simplification of the riparian ecosystem (Hussey et al, 1997).

In some circumstances weeds perform a useful role in rehabilitation and streambank stabilisation. Salt water couch (*Paspalum vaginatum*) for example, colonises bare areas on streambanks and verges and is useful in stabilising areas that would otherwise be vulnerable to erosion. This should only be considered a short-term solution and native species, including native marine couch (*Sporobolus virginicus*), bare twigrush (*Baumea juncea*) and shore rush (*Juncus kraussii*), should be encouraged to grow in their place. Weeds can also consolidate sediment slugs, preventing sediment from moving further downstream. In some circumstances however, dense weed growth in the channel can retard stream flow and cause sedimentation and raising the channel bed, subsequently leading to localised flooding (Pen, 1999).

*Image 7. Native marine couch colonising sediment*

Some high priority weeds that are, or may become, a problem to agriculture of the environment are declared under the *Agriculture and Related Resources Act Protection Act 1976 (WA)*. Landholders with declared plants on their property are obliged to control them at their own expense. Two declared plant species, one-leaf cape tulip (*Homeria flaccida*) and bridal creeper (*Asparagus asparagoides*), were found during the survey. Both of these species are listed as Priority 1 species under the Act and as such the movement of the plants or seeds within Western Australia is prohibited.

Some things to think about when deciding on how to manage a weed problem include the:

- Area(s) that should be targeted first. Generally it is good practice to target smaller infestations in good quality native vegetation first and then work towards more degraded areas;
- Order in which weeds should be removed, determined by which species are the most invasive and the size of the infestation(s);
- Control method (or combination of methods) which will be the most effective given the weed species, size of the infestation and cost; and
- Time of year you need to implement the control strategy to be most effective.

Weeds growing along road verges in close proximity to the Dale and its tributaries also need to be controlled to reduce the risk of them spreading into the riparian zone.

Broad management strategies for managing weeds include controlled stock grazing, herbicides, manual removal and natural suppression. Using herbicides in riparian areas involves some extra care to avoid spray drift and the use of chemicals that move easily through soils and could leach into waterways. There are a number

of selective and non-selective herbicides suitable for use near waterways on the market (Scheltema and Harris, 1995; Brown and Brooks, undated).

## Riparian zone revegetation

Revegetating the riparian zone has a number of benefits including:

- Improved water quality;
- Increased bank stability;
- Increased aesthetic and recreational value;
- Filtering of sediment and nutrients from streamflow and overland flow;
- Provision of essential habitat for terrestrial and in-stream fauna and corridors for native wildlife; and
- Localised salinity control (Water and Rivers Commission, 2001a; Pen, 1999).

Revegetation of the riparian zone needs to be based on realistic outcomes that are practical and realistic to achieve and maintain. Undertaking riparian revegetation presents unique challenges due to the changes in the landscape brought about by widespread land clearing. Increased flows and salinity in the Dale River catchment mean that many of the original species may not be able to survive and so plants species adapted to waterlogging and salt may need to be chosen. Badly eroded banks may need to be stabilised before planting can take place to prevent newly-established vegetation from being washed away and weeds may need to be controlled so that they do not compete with native seedlings for light, water and nutrients (Water and Rivers Commission, 2001a).

Management works need to be prioritised to gain the greatest benefit from the available resources. As a general rule, the greatest benefit to both landholders and the environment comes from protecting and enhancing areas of riparian vegetation in good condition, that is those that are relatively intact and weed-free, and then working towards more degraded areas (Water and Rivers Commission, 2001a; Price and Lovett, 1999).

The choice of species for revegetation depends very much on the reasons for revegetating and the environmental characteristics of your site, including the position of the site in the landscape, soil type and salinity and waterlogging characteristics. For example, if you were revegetating to control erosion you would choose different species than if you were planting to increase biodiversity or improve water quality. Similarly, you would choose different species if you were revegetating within the floodway as opposed to the verge or if your site was heavily salt-affected or waterlogged. Having said that, planting for any of the purposes outlined above will have multiple benefits so that revegetating to improve water quality may also have benefits for erosion control and biodiversity (Water and Rivers Commission, 2001a; Water and Rivers Commission, 1999b).

Native species suitable to use for revegetation along the Dale River include shore rush (*Juncus krausii*), native marine couch (*Sporobolus virginicus*), jam wattle (*Acacia acuminata*), swamp paperbark (*Melaleuca rhaphiophylla*), flooded gum (*Eucalyptus rudis*) and swamp sheoak (*Casuarina obesa*). Refer to Appendix 10 for revegetation tips using these, and other species.

For more detailed information on revegetating riparian areas, refer to *Riparian Plants of the Avon Catchment: A field guide* by Brendan Oversby, available from the ACC in Northam by contacting (08) 9690 2250.

## Fire management

The dominance of grassy, annual weeds in the understorey and the fact that the vegetation along the Dale River exists as a corridor, may pose a fire risk. A severe and uncontrolled fire in the riparian zone could potentially cause damage to farm assets, such fences, stock and native vegetation, as well as reducing habitat available for native fauna and leaving the riparian zone vulnerable to weed invasion and erosion. Under controlled circumstances, where risks are minimised, fire can be beneficial to native vegetation by stimulating some plant species to germinate however in most cases fire exclusion, rather than use, is the management aim (Price and Lovett, 1999).

Firebreaks along foreshore verges are important to protect fragile riparian vegetation and fences from unintentional fires that may result from stubble burning in adjacent paddocks. Firebreaks and fences along riparian verges should be maintained and upgraded if necessary. When fencing for riparian zone protection, firebreaks should be located on the river side of the fence, allowing easy access to the area and preventing stock from pushing through fences to graze on the other side of the fence. It is also important that there is vehicle access to the riparian zone so that fires that break out in this area can quickly be controlled.

The AWC has developed a fire policy setting out objectives for bushland management in and around the Avon River and its major tributaries (refer to Appendix 11). The main aims of the policy are to protect river ecosystems from uncontrolled fires, while managing the fire hazard in riparian areas to minimise the threat to the river environment and adjacent land holders.

## Stock access to the foreshore

Unrestricted stock access to foreshore areas has a number of damaging effects that include grazing and trampling of vegetation, prevention of regeneration, soil compaction, decreased bank stability leading to increased erosion and sedimentation, dispersal of weeds and declining water quality due to nutrients and sediment.

There are many advantages of fencing waterways, both to farmers and the environment including:

- Reduced stock losses from flooding;
- More freedom to leave the property as stock do not have be checked as often;
- Time saved rounding up stock;
- Reduction in the amount of productive land lost to erosion;
- Provision of shelter for stock from riparian vegetation acting as a windbreak;
- Improved water quality;
- Fewer cross-creek fences;
- Improved bank stability; and
- Improved property appearance and resale value (Rutherfurd et al, 2000; Bell and Priestley, 1998).

The easiest way to exclude stock from riparian areas is by fencing and constructing stock crossings and watering points. In some circumstances it is not practical to completely exclude stock. If riparian land is to be grazed, for example for weed control, there are a couple of guidelines that can be followed:

- Only graze riparian areas when soil is relatively dry and the bulk of the vegetation is dormant;
- Avoid grazing during the growing, flowering and germination seasons of native vegetation, which typically

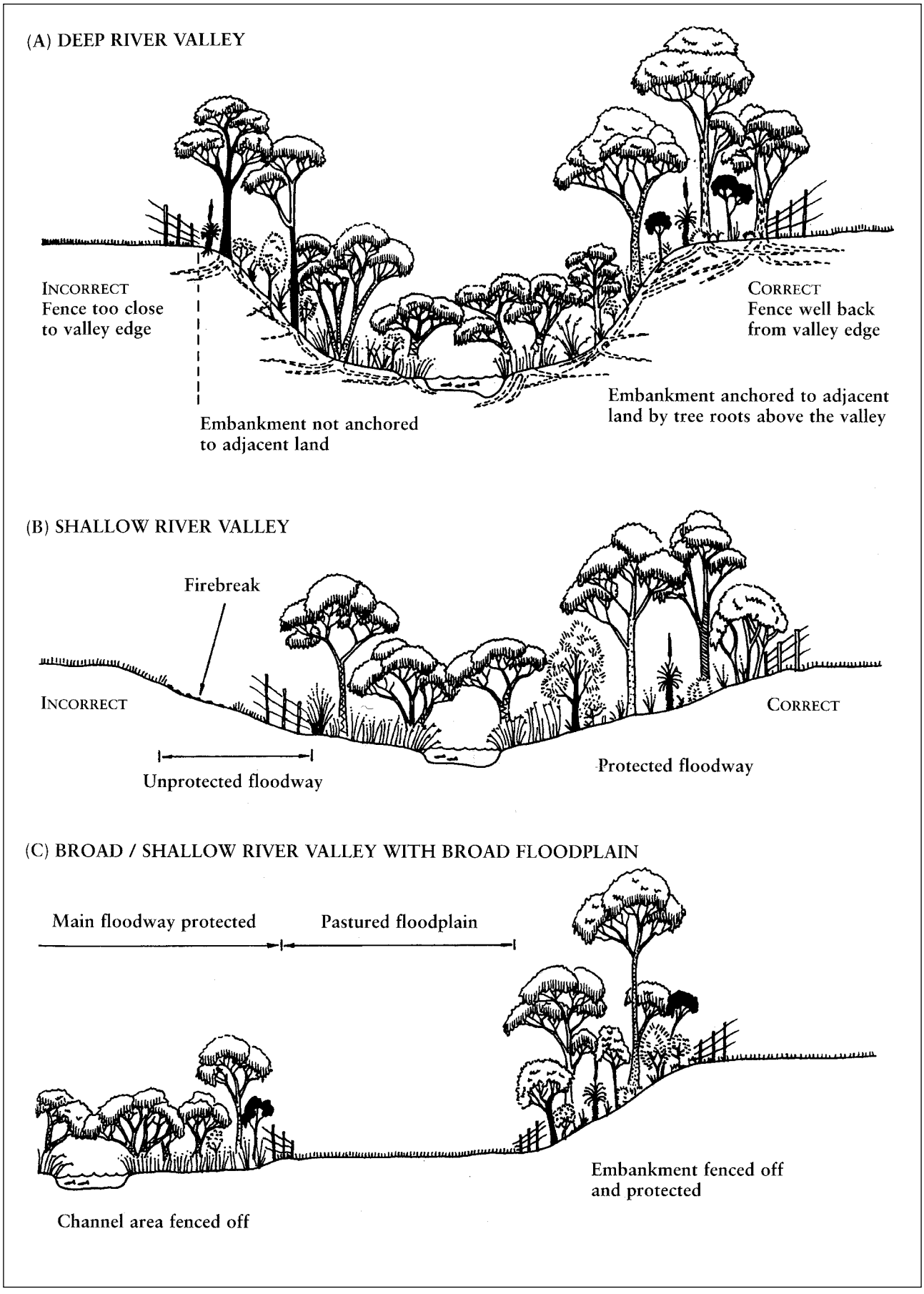



*Figure 6. Ideal fence placement along river floodways Source: L. Pen 1999*

means spring and summer; and

- Adjust stocking rates and frequency of grazing to suit the sensitive nature of the land (Price and Lovett, 1999).

A frequently asked question in relation to fencing waterways is: How far away from a waterway should the fence be placed? The ideal width of the fenced area depends on a number of factors including the form of the river valley, the presence of riparian vegetation that needs to be protected and frequent flood levels. The fenced off area must be able to function as a waterway and wherever possible the floodway should be included, both to contribute to waterway functioning, reduce stock and property losses and reduce fence repair and maintenance. As a general guide, a river fence along a major waterway, such as the Dale River, should ideally be located approximately 30–100 m from the edge of the channel. Figure 6 demonstrates ideal fence placements along river valleys with different forms (Water and Rivers Commission 2000e).

To assist landholders in the Avon River catchment, DoW and ACC developed the Avon Fencing Project, which supplies materials for the fencing of foreshore areas. Landholders whose property lies adjacent to the Avon River or its tributaries (including the Dale River) 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 DoW Northam office on (08) 9622 7055.

There are a number of fences along the Dale River that cross the main channel, a necessity in many instances to prevent livestock from wandering onto neighbouring properties. Where possible fences should be located on a straight section of the river or at the crossover point on a meander bend and not on meander bends where fences may exacerbate scouring (Water and Rivers Commission, 2000f).

Fences can be constructed to resist flood damage by constructing them with the least vertical height that gives adequate stock control, locating posts as close together as possible and in as firm soil as possible, that is in clay as opposed to sandy soils. Fences crossing waterways also need regular maintenance to prevent damage from accumulating flood debris (Images 8 and 9).

Stock crossings protect livestock and the river from all the problems associated with unrestricted access plus they have the added benefit of acting as ‘riffles’ which aerate the water, trap sediment and provide habitat for aquatic fauna. Stock crossings should not adversely affect the flood conveyance or stability of the channel. Site selection for crossings is the most important consideration as incorrect siting can exacerbate erosion and cause the crossing to be washed out (Image 10). Crossings should always be sited along straight sections of the waterway or on the crossover point of a meander bend. The crossing should be as low as is practicable, be constructed by bed hardening, for example using rock, and should not change the profile of the channel. It is also good practice to extend the rock cover up the banks to the high water mark to provide better footing for stock and prevent damage to banks caused by livestock and scouring from high flows (Water and Rivers Commission, 2000a).

On-stream watering points (Figure 7) are relatively simple to construct and maintain provided they are located properly. The width of the construction can vary from between 2–20 m depending on stock numbers and how many access points

*Figure 7: On-stream stock watering point (Source: Water and Rivers Commission, 2000b)*

are available. It is good practice to locate access points on the inside of a bend where water movement is slowest and there is less chance of scouring. The outer bend of meanders is where banks actively erode and is therefore more sensitive to trampling. Other things to keep in mind are to site access points where:

- Streambank gradients are relatively low (1:6 or under) to prevent erosion and enable stock to easily access water; and
- Access ramps can be angled away from direction of flow (Water and Rivers Commission, 2000a; Lovett and Price, 1999).

While on-stream access points minimise trampling of the banks, they do not prevent nutrients entering the water and, unless they are sited properly and regularly maintained, they can cause serious erosion problems. Pumping water from waterways directly into a trough or tank is a good alternative to the construction of on-stream watering points. There are a number of options available including electrical mains, solar, wind, petrol and diesel powered systems (Water and Rivers Commission, 2000b).

More information on fencing waterways and installing stock crossings and watering points is available from DoW in Northam on (08) 9622 7055 or on the Department website <www.environment.wa.gov.au>.

## Water quality

Poor water quality can significantly affect the health of the river and surrounding ecosystems. As in many other catchments throughout the Avon, land clearing in the catchment has resulted in a decrease in the water quality in the Dale River and its tributaries, including increases in sediment, nutrient loads and salinity. Having said that, the river and many of its tributaries are of stock water quality and the river is one of the fresher waterways in the wider Avon catchment.

The most effective way to manage water quality is through integrated catchment management, where the catchment is managed as a whole across the diverse range of social, economic and ecological activities that occur. These recommendations are beyond the scope of this report however there are a number of management activities that can be implemented along the Dale River and its tributaries to improve water quality.

Restoring the fringing vegetation along the main channel of the Dale River and its tributaries is an important step in improving water quality. This could be achieved through fencing to exclude stock (except for crash grazing to control weeds), installing fenced or off-stream watering points, weed control and revegetation. Restoring fringing vegetation would improve water quality by improving bank stability to minimise erosion and sedimentation and filtering nutrients and sediments from streamflow and runoff.

*Image 8. Debris caught in a cross-channel fence*

*Image 9. A well-constructed, well-maintained cross-channel fence*

*Image 10. Incorrect placement of this crossing has caused it to be washed out and the banks to erode*

As well as allowing natural regeneration of native species, stock exclusion has the added benefit of reducing the direct contribution of manure to the nutrient load in the river.

From a nutrient-management point of view it is also important to manage point sources of pollution, for example stock yards close to the river, that may contribute high concentrations of nutrients into the river. If possible stock yards should be located well away from riparian areas and other water sources, such as dams, drains or waterways. If, due to land constraints, this is not possible it is vital to manage surface water flow so that runoff does not transport manure into nearby water sources.

## Development

### Subdivision

In recent years some rural land in the Dale River catchment has been subdivided for hobby farming or rural residential. Applications for subdivision are assessed by the Western Australia Planning Commission and, if necessary, referred to relevant organisations, including DoW. When a proposed development is situated adjacent to a waterway it is general practice to request a foreshore management reserve or plan.

While many of the older titles along the Dale River give ownership across the river, where titles have changed hands foreshore reserves have been created to protect the environmental, social and economic values of the Dale River.

### Flooding risk

When planning developments along the Dale River, the flood regime needs to be taken into account so that damage caused by flooding is minimised. Development within the floodway is not recommended due to the risk to the infrastructure and so that flood waters are not obstructed

causing increased flood levels upstream. Development within the flood fringe is acceptable however it is recommended that the floor level be a minimum of 0.5 m above the adjacent 1:100 year flood level (if known) to ensure adequate flood protection (Water and Rivers Commission, 2000d).

### Areas of cultural significance

Areas of cultural significance (both Aboriginal and European) in the Dale River catchment should be recorded and protected through local Town Planning Schemes to prevent any changes in land use that would be detrimental to these sites. Sites listed under the *Heritage of Western Australia Act 1990 (WA)* must be conserved to maintain their heritage value.

Where Aboriginal sites of significance may be affected by development, the requirements of the *Aboriginal Heritage Act 1972 (WA)* must be met. There is also a requirement under the Act to seek permission for environmental restoration works, including river restoration and erosion control measures, that may impact on a significant site. Even where there are no significant sites listed under the Act, the appropriate local Aboriginal Elders should be consulted prior to restoration works being carried out (Water and Rivers Commission, 2002b). At the time of writing, Buddy Ugle and Mitch Henry are recognised as the local Elders for the Beverley area.

### Protection of native vegetation

New legislation was proclaimed on 8 July 2004 that protects all native vegetation. This new legislation replaces the ‘Notice of Intent to Clear’ process administered under the *Soil and Land Conservation Act 1950 (WA)*. Under amendments to the *Environmental Protection Act 1986 (WA)* it is now illegal to clear native vegetation without a clearing permit granted by the DoE, unless the clearing is for an exempt purpose. However, exemptions do not apply in identified Environmentally Sensitive Areas such as wetlands and riparian areas.

More information, including the location of Environmentally Sensitive Areas, is available from the DoE website <www.environment.wa.gov.au> or by phoning the Northam office on (08) 9622 7055.

## Large woody debris

Large woody debris (or snags) refers to branches, large limbs or whole trees lying in the channel. It is an essential component of the river ecosystem, providing habitat to a myriad of aquatic fauna and physically protecting banks from erosion (Figure 8). It is a common belief that the presence of large woody debris causes flooding and that its removal will increase flood conveyance. This is the reason that large woody debris was removed from the Avon River through the Avon River Training Scheme between 1958 and 1970.

Removal of snags does increase flow velocity, but doesn’t necessarily reduce flood risk, and comes at the cost of significantly reducing bank stability and river habitat. One of the effects of the training scheme on the Avon River has been the in-filling of river pools with mobilised sediment, resulting in a loss of habitat and recreation areas (Pen, 1999; Harris, 1996)

When restoring snags, the natural load of the waterway can be estimated from looking at the amount of wood present in undisturbed reaches of the waterway (or in nearby waterways under the same conditions). Snags are best placed on the outside and downstream of bends to help minimise erosion. In some cases natural large woody debris may be deflecting flows into banks and causing erosion. In these

situations snags can be re-angled so as to protect the eroding bank (Price and Lovett, 1999).

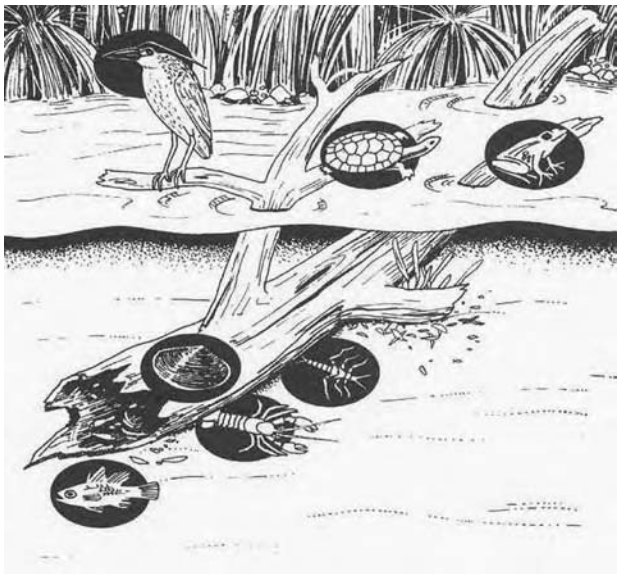


*Figure 8. Habitat provided by large woody debris (Source: Water and Rivers Commission, 2000g)*

## Sediment management

Sedimentation is a significant problem along the Dale River. Deep river pools that were once used for boating, swimming and fishing are now shallow ponds choked with sediment (Image 11). Sediment slugs are common along the main channel, smothering habitat and in some cases causing further erosion by deflecting flow into the river banks.

Erosion is a naturally occurring process and there is always some degree of erosion and sedimentation occurring in a waterway. The problems occur when there is too much erosion and sedimentation. Eroded sediment is comprised of fine particles (silts and clays), suspended in the water column, and coarser sand particles and gravels which roll along the channel bed. These coarse sediments build up and form slugs when the flow velocity is reduced by natural pools, log jams and when flows dry up in summer (Pen, 1999).

Excess sediment causes problems in the river environment as it smothers aquatic habitats, fills in river pools and exacerbates the scouring action of water on the banks. While in the short term it can reduce incision of the channel, it can also contribute to flooding and deflect flows into banks causing further erosion. Sediment also causes further water quality problems as some pollutants, such as phosphorus and pesticides, absorb to fine particles and so increased turbidity is usually indicative of an increased pollutant load (Department of Environment, 2003; Water and Rivers Commission, 2000c; Pen, 1999).

The strategy for sediment management really depends on how much sediment is present and whether it is causing a problem, for example where stabilised sediment is deflecting flow into banks and causing further erosion. If sediment slugs don't pose a risk to bank stability then suitable native species, such as native marine couch (*Sporobolus virginicus*) or shore rush (*Juncus krausii*), can be planted to stabilise the plume. Some of the sediment slugs in the Dale River have colonised naturally, either by native marine couch or sedges or rushes but most commonly by salt water couch (*Paspalum vaginatum*). Where plumes are causing problems, sediment may need to be mechanically removed or encouraged to move further downstream, either by grazing to de-stabilise the plume or deflecting flow into the plume (Pen, 1999).

In conjunction with mobilising or stabilising existing sediment slugs, the sediment source also needs to be managed by stabilising banks to prevent further erosion. Where the sediment source is bank erosion, river banks need to be stabilised using techniques such as revegetation, rebuilding pool-riffle sequences and replacing large woody debris. Where soil erosion in nearby paddocks is a significant sediment source, surface water needs be managed to prevent erosion.

*Image 11. Sediment choking Mandiakin Pool*

Planting native vegetation increases bank stability and additionally provides habitat and improves water quality by filtering sediment and nutrients. A list of suitable species for riparian revegetation in the Dale catchment is provided in Appendix 10. Severely eroded banks may need stabilising prior to replanting to prevent plants from being washed away.

Where channel incision is the main cause of bank instability, the re-creation of pool-riffle sequences can be effective. The technique involves placing rocks or logs in straight sections or at meander crossovers to raise the channel bed and reduce the channel gradient, which effectively reduces flow velocity and encourages coarse sediment to drop out. Riffles have the added benefits of providing stable stock and vehicle crossings (Pen, 1999; Water and Rivers Commission, 1999b).

## Feral animals

From discussions with landholders and field observations it is clear that there are a number of feral animals within the riparian zone of the Dale River including foxes, rabbits, cats and pigs.

Feral animals take over habitat, prey on native fauna, destroy native vegetation, increase the spread of weeds, contribute to bank destabilisation through burrowing and can pose a threat to livestock (Scheltema and Harris, 1995). Table 12 summarises the problems caused by feral animals and possible control methods. Feral animal control is an issue that needs to be addressed by landholders across the whole catchment to be effective.

## Rubbish disposal

Along some sections of the Dale River old farm machinery, car bodies, fencing materials and chemical drums have been

*Table 12. Problems and control of feral animals (Department of Environment and Heritage, 2004a-d)*

| Feral animal | Problems | Control methods |
|---|---|---|
| European wild rabbit (*Oryctolagus cuniculus*) | • Ringbarks trees<br>• Prevents regeneration of native plants<br>• Competes with stock and native fauna for food | • Destroying warrens<br>• Shooting<br>• Poisoning<br>• Trapping<br>• Biological control using myxoma virus or calicivirus |
| European red fox (*Vulpes vulpes)* | • Predates native fauna<br>• Predates livestock including lambs and poultry | • Shooting<br>• Baiting |
| Feral cat (*Felis catus*) | • Predates native fauna<br>• Predates livestock such as poultry<br>• Carry infectious diseases | Control is difficult as feral cats do not readily take baits or approach traps. They are difficult to shoot as they are wary of humans |
| Feral pig (*Sus scrofa*) | • Compete with native fauna for food<br>• Destroy native vegetation and destabilise river banks by trampling and wallowing<br>• Kill livestock<br>• Damage crops<br>• Carry infectious diseases | • Trapping<br>• Shooting |

disposed of on the banks of the river. While it may seem unlikely that fairly inert rubbish such as fencing wire will cause much damage, riparian areas are highly sensitive environments and the presence of any rubbish has the potential to degrade these areas and affect the aesthetics of the riverine environment. More problematic are the pollutants, such as oil, fuel and chemicals, that may leak from old car bodies and chemical drums and leach into the river. These substances are highly toxic and can cause significant environmental damage, both to the Dale River and downstream waterways such as the Avon River.

## Education and awareness

An important measure for the long term health of the Dale River is the continuing flow of information amongst stakeholders to promote an understanding and awareness of the significance of the Dale River and how the river can be best managed so that it's health is maintained and improved.

Landowners and other stakeholders were given the opportunity to take part in the River Recovery Plan process and the foreshore and channel assessment and it is vital that this involvement is on going in any future plans to improve the health of the Dale River.

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# Glossary

| | |
|---|---|
| **Algal bloom** | The rapid excessive growth of algae, generally caused by high nutrient levels and favourable conditions. |
| **Anabranch** | A secondary channel of a river which splits from the main channel and then later rejoins the main channel. |
| **Bank** | The steeper part of a waterway channel cross section, which is usually considered to lie above the usual water level. |
| **Bed stability** | When the average elevation of the streambed does not change much through time. |
| **Carrying capacity** | The maximum population of organisms or the maximum pressure that an environment can support on a sustainable basis over a given period of time. |
| **Catchment** | The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater. |
| **Channelisation** | The straightening of the river channel by erosional or mechanical processes. |
| **Contour farming** | Ploughing and planting along the contour of the land, rather than in straight lines, to help retain water and reduce soil erosion. |
| **Debris** | Loose and unconsolidated material resulting from the disintegration of rocks, soil, vegetation or other material transported and deposited during erosion. |
| **Degradation** | Specifically for waterways, the general excavation of a streambed by erosional processes over a number of years. Has a broader meaning of reduction in quality. |
| **Discharge** | Volumetric outflow of water, typically measured in cubic metres per second. |
| **Ecosystem** | A term used to describe a specific environment, eg lake, to include all the biological, chemical and physical resources and the interrelationships and dependencies that occur between those resources. |
| **Electrical conductivity (EC)** | A measure of salinity. The higher the electrical conductivity of a stream the greater the salinity. |
| **Electric fence** | Any fence design which is electrified, irrespective of whether it consists of electric tape, a single smooth electric wire or four plain wires of which two are electric. |
| **Environment** | All the biological and non-biological factors that affect an organism's life. |
| **Environmental degradation** | Depletion or destruction of a potentially renewable resource such as soil, grassland, forest, or wildlife by using it at a faster rate than it is naturally replenished. |

| | |
|---|---|
| **Erosion** | The subsequent removal of soil or rock particles from one location and their deposition in another location. |
| **Eutrophication** | An excessive increase in the nutrient status of a waterbody. |
| **Evaporation** | A physical change in which liquid changes into a vapour or gas. |
| **Exotic vegetation** | Introduced species of vegetation from other countries or from other regions of Australia (ie not endemic to the region). |
| **Fabricated fence** | Includes rabbit netting, sheet metal and hinge joint fences. |
| **Floodfringe** | The area of the floodplain, outside the floodway, which is affected by flooding. This areas is generally covered by still or very slow moving waters during the 100 year flood. |
| **Floodplain** | A flat area adjacent to a waterway that is covered by floods every year or two. |
| **Floodway** | The river channel and portion of the floodplain which forms the main flow path of flood waters once the main channel has overflowed. |
| **Floodway and bank vegetation** | Vegetation which covers the floodway and bank part of the riparian zone. The vegetation which actually grows in the floodway or on the banks above the stream. |
| **Foreshore** | Area of land next to a waterway. |
| **Groundwater** | Water which occupies the pores and crevices of rock or soil. |
| **Habitat** | The specific region in which an organism or population of organisms live. |
| **Hydrology** | The study of water, its properties, distribution and utilisation above, on and below the earth’s surface. |
| **Large woody debris** | A branch, tree or root system that has fallen into or is immersed (totally or partially) in a waterway. |
| **Leaf litter** | The uppermost layer of organic material in a soil, consisting of freshly fallen or slightly decomposed organic materials which have accumulated at the ground surface. |
| **Levee** | An artificial embankment or wall built to exclude flood waters, or a natural formation next to a waterway built by the deposition of silt from floodwaters. |
| **Monitoring** | The regular gathering and analysing of information to observe and document changes through time and space. |
| **Native species** | Species that normally live and thrive in a particular ecosystem. |
| **Organism** | Any form of life. |
| **Overgrazing** | Destruction of vegetation when too many animals feed too long and exceed the carrying capacity of an area. |

| | |
|---|---|
| **Pest plant** | Weed species that are seen as being a nuisance to the existing land use. Local government authorities can enforce the control of such a species. |
| **pH** | Technically this is the hydrogen ion (H+) concentration in the water. It is the simplest measure of acidity/alkalinity. |
| **Pollution** | Any physical, chemical or biological alteration of air, water or land that is harmful to living organisms. |
| **Regeneration** | Vegetation that has grown from natural sources of seed, from vegetative growth, or has been artificially planted. |
| **Riffle** | The high point in the bed of the stream (accumulation of coarse bed materials) where upstream of accumulations a shallow pool is formed. Downstream from the crest of the accumulation the water is often shallow and fast flowing. |
| **Riparian zone** | Refers to the zone directly adjoining a waterway. Any land that adjoins, directly influences, or is influenced by a body of water. |
| **Salinisation** | The accumulation of salts in soil and water which causes degradation of vegetation and land. |
| **Sediment** | Soil particles, sand and other mineral matter eroded from land and carried in surface waters. |
| **Sedimentation** | The accumulation of soil particles within the channel of a waterway. |
| **Slumping** | The mass failure of part of a stream bank. |
| **Snags** | Large woody debris such as logs and branches that fall into waterways. |
| **Subsidence** | The sinking of parts of the ground which are not slope related. |
| **Terrestrial** | Relating to land. |
| **Threatened Ecological Community** | A Threatened Ecological Community is one that is either presumed totally destroyed, critically endangered, endangered or vulnerable. |
| **Turbidity** | A measure of the suspended solids in the water. |
| **Undercutting** | The undermining or erosion of soil by water from underneath an existing landform (ie riverbank), structure (i.e fence post) or vegetation (ie tree). |
| **Verge** | The area extending from the top of the bank to the next major vegetation or land use change. |
| **Verge vegetation** | The strip of land up to 20 m from the immediate river or creek valley. |
| **Waterlogging** | Saturation of soil with irrigation water or excessive rainfall, so that the water table rises close to the surface. |
| **Water quality** | The physical, chemical and biological measures of water. |
| **Weed** | A plant considered undesirable, unattractive, or troublesome, especially growing where it is not wanted. |

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# Appendix 1 Soil units of the Dale River catchment

*Table A1.1: Soil unit descriptions (CSIRO, 1967)*

| Soil unit | Soil unit description |
|---|---|
| JZ2 | Dissected plateau having a gentle to moderately undulating relief, and with broad swampy drainage-ways and basins. It is characterized by lateritic gravels and block laterite: the chief soils are ironstone gravels with sandy and earthy matrices (KS-Uc4.2), (KS-Uc4.11), (KS-Gn2.24), and (KS-Uc2.12). They overlie duricrusts of recemented ironstone gravels and/or vesicular laterite, and/or mottled-zone and/or pallid-zone material. These soils cover ridges and slopes where some (Dy3.81 and Dy3 .82) soils containing ironstone gravels also occur. Leached sands (Uc2.2 and Uc2.3) are a feature of the drainage-ways and basins. Areas of (Dy5.41) and (Dy5.82) soils occur on pediments in some areas of this unit where it merges with unit Tf3. |
| Ms7 | Very gently undulating plains: dominant soils are sandy or, less commonly, loamy yellow earths (Gn2.22 and Gn2.25), with lesser loamy red earths (Gn2.12). Closely associated are slightly depressed areas with grey cracking (Ug5.25, Ug5.24, and Ug5.29) clays of unit CC38. Marginal to the small clay plains are loamy duplex soils (Dy2.43), (Dy3.43), and (Dy3.42). |
| Oc30 | River terraces: chief soils are hard alkaline red soils (Dr2.33). Associated are some (Dy3.43) soils; and small areas of other soils are likely. As mapped, areas of soils of unit Qb29 may be included. |
| Tf3 | Low hilly to hilly terrain that occupies a zone flanking unit JZ2. It comprises valleys that are frequently narrow and have short fairly steep pediments, along with breakaways, mesas, and occasional granite tors. Included also are undulating areas representing elements of unit JZ2: chief soils are hard acidic yellow mottled soils (Dy3.81) along with sandy acidic yellow mottled soils (Dy5.41) and (Dy5.81), all of which contain moderate to large amounts of ironstone gravels in their surface horizons. Ironstone gravels (KS-Uc4.2) occur on the ridge crests and on the fine gravel deposits of the gently undulating parts of the unit, along with leached sands (Uc2.21). |
| Qb29 | Rolling to hilly with some steep slopes; gneissic rock outcrops common: chief soils are hard neutral red soils (Dr2.22) with others such as (Dr2.62) and (Dr3.42). Associated are (Dy3.42) soils on slopes; patches of (Ug5.37) and (Ug5.2) soils with some gilgai also on slopes; colluvial slopes of (Gn2) soils such as (Gn2.12) and (Gn2.45); and variable areas of other soils seem likely. As mapped, areas of unit Uf1 and small areas of unit Oc30 may be included. |
| Ub91 | Undulating to hilly with some steep slopes; tors common; some lateritic mesas and buttes on drainage divides: chief soils are hard neutral and alkaline yellow mottled soils (Dy3.42 and Dy3.43). Associated are (Dy3.82) soils containing ironstone gravels; and small areas of (Dr) soils, such as (Dr2.22), may occur. The landscape of this unit is similar to that of units Qb29 and Qb30 but (Dy) soils, not (Dr) soils, seem characteristic. |
| Ub96 | Valley plains in which some salinity is usually present: chief soils are hard neutral, and also alkaline, yellow mottled soils (Dy3.42 and Dy3.43). Associated are small areas of many other soils including minor areas of sands as for unit Ub95. As mapped, areas of adjoining units may be included. |
| Uf1 | Undulating terrain with ridges, spurs, and lateritic mesas and buttes: chief soils on the broad undulating ridges and spurs are hard, and also sandy, neutral, and also acidic, yellow mottled soils (Dy3.82 and Dy3.81), (Dy5.82 and Dy5.81), all containing ironstone gravels. Associated are a variety of soils on the shorter pediment slopes, including (Dr2.32), (Dr3.41), (Dy2.33), and others of similar form; and dissection products of the lateritic mesas and buttes. As mapped, small areas of unit Ms7 may occupy some drainage divides, unit Va63 traverse some drainage-ways, and unit Qb29 occur in localities of deeper dissection. |

# Appendix 2
# Results of water quality snapshot, 17 June 2005

*Table A2.1. Site details*

| Site number | Site name | Easting | Northing |
|---|---|---|---|
| 1 | Dale River, Great Southern Hwy | 484218 | 6450919 |
| 2 | Tributary, York-Williams Rd | 483661 | 6447593 |
| 3 | Dale River, Waterhatch Rd | 484520 | 6446565 |
| 4 | Talbot Brook, York-Williams Rd | 480979 | 6441184 |
| 5 | Christopher Brook, off York-Williams Rd | 480837 | 6440915 |
| 6 | Maitland Swamp drain, Deep Pool Rd | 484826 | 6436115 |
| 7 | Geedaping Gully, Beverley-Westdale Rd | 475837 | 6429806 |
| 8 | Dale River, Hobbs Road | 475949 | 6428869 |
| 9 | Dale River, Butchers Rd | 475010 | 6427735 |
| 10 | Turner Gully, Williamson Rd | 474466 | 6426215 |
| 11 | Dale River, Lupton Rd | 470718 | 6426119 |
| 12 | Sherlock Gully, Lupton Rd | 470929 | 6425581 |
| 13 | Sherlock Gully, Lupton Rd | 469051 | 6421147 |
| 14 | Dale River, Brookton Hwy | 463762 | 6423112 |
| 15 | Kettlerock Gully, Beverley-Westdale Rd | 468302 | 6426882 |
| 16 | Dale River South, Dale Corbeding Rd | 480236 | 6429621 |
| 17 | Mile Pool, Dale River, Beverley-Westdale Rd | 483414 | 6438310 |
| 18 | Connelly Gully, Pike Road | 462816 | 6422085 |

*Table A2.2. Water quality results*

| Site number | Temp (°C) | Turbidity (NTU) | pH | TDS (mg $L^{-1}$) | Salinity Classification |
|---|---|---|---|---|---|
| 1 | 11.3 | 20-30 | 8.04 | 1980 | Brackish |
| 2 | 11.4 | 0-10 | 8.48 | 699 | Marginal |
| 3 | 10.7 | 20-30 | 7.82 | 2151 | Brackish |
| 4 | 10.7 | 40-50 | 7.77 | 1518 | Brackish |
| 5 | 10.4 | 10-15 | 7.81 | 1061 | Marginal |
| 6 | 11.4 | 10-15 | 7.95 | 949 | Marginal |
| 7 | 11.4 | 0-10 | 7.13 | 2145 | Brackish |
| 8 | 11.1 | 10-15 | 7.49 | 2332 | Brackish |
| 9 | 10.7 | 10-15 | 7.51 | 2349 | Brackish |
| 10 | 12.2 | 0-10 | 7.57 | 1892 | Brackish |
| 11 | 11.4 | 0-10 | 7.08 | 2613 | Brackish |
| 12 | 11.7 | 10-15 | 7.57 | 2783 | Brackish |
| 13 | 12.1 | 10-15 | 7.66 | 3515 | Brackish |
| 14 | 11.2 | 10-15 | 8.06 | 2734 | Brackish |
| 15 | 12.7 | 10-15 | 8.09 | 1980 | Brackish |
| 16 | 11.6 | 20-30 | 7.94 | 3366 | Brackish |
| 17 | 10.9 | 0-10 | 7.44 | 2992 | Brackish |
| 18 | 11.6 | 20-30 | 7.84 | 3229 | Brackish |

# Appendix 3 Water quality snapshot results, 1997

*Table A3.1. Site details*

| Site number | Site description | Easting | Northing |
|---|---|---|---|
| AS51 | Dale River, Great Southern Highway | 484191 | 6449671 |
| AS52 | Talbot Brook, Kokendin Rd (Talbot Rd) | 478000 | 6445800 |
| AS53 | Christopher Brook, York-Williams Road | 482225 | 6440232 |
| AS54 | Dale River, Romilly, Brookton Highway | 465286 | 6422167 |
| AS55 | Dale River, Boyadine, York-Williams Rd | 479304 | 6430489 |
| AS56 | Dale River South Bejoording Pool, Dale-Kokeby Road | 480130 | 6429576 |

*Table A3.2: Water quality results for June 1997*

| Site code | Total phosphorus (mg $L^{-1}$) | Filterable reactive phosphorus (mg $L^{-1}$) | Total Kjeldahl nitrogen (mg $L^{-1}$) | Nitrogen as ammonia (mg $L^{-1}$) | Total oxidised nitrogen (mg $L^{-1}$) | Total nitrogen (mg $L^{-1}$) | Electrical conductivity (mS/m) | Total suspended solids (mg $L^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| AS51 | 0.024 | 0.009 | 0.760 | 0.005 | 0.085 | 0.850 | 1200 | 7 |
| AS52 | 0.024 | 0.011 | 0.740 | 0.056 | 0.200 | 0.940 | 1200 | 6 |
| AS53 | 0.025 | 0.013 | 0.660 | 0.053 | 0.160 | 0.820 | 1000 | 6 |
| AS54 | No flow | No flow | No flow | No flow | No flow | No flow | No flow | No flow |
| AS55 | 0.029 | 0.012 | 0.860 | 0.093 | 0.320 | 1.200 | 1300 | 6 |
| AS56 | 0.024 | 0.010 | 0.810 | 0.057 | 0.013 | 0.830 | 1300 | 14 |

*Table A3.3: Water quality results for July 1997*

| Site code | Total phosphorus (mg/L) | Filterable reactive phosphorus (mg/L) | Total Kjeldahl nitrogen (mg/L) | Nitrogen as ammonia (mg/L) | Total oxidised nitrogen (mg/L) | Total nitrogen (mg/L) | Electrical conductivity (mS/m) | Total suspended solids (mg/L) |
|---|---|---|---|---|---|---|---|---|
| AS51 | 0.017 | 0.0025 | 0.58 | 0.005 | 0.005 | 0.58 | 1100 | 5 |
| AS52 | 0.012 | 0.006 | 0.4 | 0.005 | 0.005 | 0.4 | 1300 | 2 |
| AS53 | 0.016 | 0.0025 | 0.45 | 0.033 | 0.037 | 0.48 | 850 | 2 |
| AS54 | 0.012 | 0.0025 | 0.38 | 0.06 | 0.16 | 0.54 | 1500 | 4 |
| AS55 | 0.014 | 0.0025 | 0.51 | 0.005 | 0.005 | 0.51 | 1300 | 2 |
| AS56 | 0.011 | 0.0025 | 0.49 | 0.005 | 0.005 | 0.49 | 1300 | 2 |

*Table A3.4: Water quality results for August 1997*

| Site code | Total phosphorus (mg/L) | Filterable reactive phosphorus (mg/L) | Total Kjeldahl nitrogen (mg/L) | Nitrogen as ammonia (mg/L) | Total oxidised nitrogen (mg/L) | Total nitrogen (mg/L) | Electrical conductivity (mS/m) | Total suspended solids (mg/L) |
|---|---|---|---|---|---|---|---|---|
| AS51 | 0.014 | 0.0025 | 0.58 | 0.019 | 0.005 | 0.57 | 880 | 4 |
| AS52 | 0.017 | 0.0025 | 0.62 | 0.14 | 0.005 | 0.63 | 1000 | 5 |
| AS53 | 0.015 | 0.0025 | 0.44 | 0.017 | 0.005 | 0.44 | 840 | 4 |
| AS54 | 0.015 | 0.0025 | 0.57 | 0.051 | 0.17 | 0.74 | 1000 | 6 |
| AS55 | 0.048 | 0.017 | 0.74 | 0.045 | 0.005 | 0.74 | 970 | 4 |
| AS56 | 0.011 | 0.0025 | 0.41 | 0.019 | 0.005 | 0.41 | 1100 | 5 |

*Source: Water and Rivers Commission, 1997c*

# Appendix 4
# Summary of streamflow and water quality data for Waterhatch and Brookton Highway gauging stations

*Table A4.1. Department of Environment: Station 615222 – Dale River South – Brookton Highway*

| Parameter | Unit | Minimum | Maximum | Average | Number of readings | First reading | Last reading |
|---|---|---|---|---|---|---|---|
| Al (tot) | mg/L | 0.10 | 0.10 | 0.10 | 1 | 17.11.97 | 17.11.97 |
| Alkalinity ($CO_3$-$CO_3$) | mg/L | 0.00 | 11.00 | 0.88 | 32 | 03.06.81 | 08.06.88 |
| Alkalinity ($HCO_3$-$HCO_3$) | mg/L | 23.00 | 531.00 | 202.34 | 32 | 03.06.81 | 08.06.88 |
| Alkalinity (tot) ($CaCO_3$) | mg/L | 18.86 | 516.00 | 194.78 | 61 | 18.11.69 | 08.06.88 |
| C (sol org) {DOC} | mg/L | 6.87 | 16.06 | 10.98 | 4 | 11.10.94 | 31.07.96 |
| Ca (sol) | mg/L | 14.00 | 206.00 | 118.69 | 32 | 03.06.81 | 08.06.88 |
| Cl (sol) | mg/L | 287.00 | 12132.00 | 4087.64 | 230 | 12.07.66 | 08.06.88 |
| Colour (TCU) | none | 48.00 | 48.00 | 48.00 | 1 | 21.05.99 | 21.05.99 |
| Colour (hazen) | Hu | 18.00 | 300.00 | 58.71 | 51 | 20.07.77 | 30.06.86 |
| Colour (true) | Hu | 5.00 | 700.00 | 71.16 | 1508 | 18.11.69 | 14.10.98 |
| Conductivity calc 25°C | µs/m | 1572000.00 | 1572000.00 | 1572000.00 | 1 | 05.12.94 | 05.12.94 |
| Conductivity uncompensated | µs/m | 162400.00 | 1561000.00 | 957166.69 | 30 | 01.09.83 | 23.09.03 |
| Cond uncomp (lab) | µs/m | 100300.00 | 2510000.00 | 1060683.38 | 1642 | 21.05.99 | 04.04.73 |
| Fe (tot) | mg/L | 0.15 | 1.28 | 0.52 | 7 | 05.05.92 | 17.11.97 |
| Hardness (tot) | mg/L | 85.00 | 4940.00 | 1956.60 | 61 | 18.11.69 | 08.06.88 |
| K (tot) (mg/L) | mg/L | 3.00 | 17.00 | 10.34 | 32 | 03.06.81 | 08.06.88 |
| Mg (sol) | mg/L | 28.00 | 582.00 | 318.75 | 32 | 03.06.81 | 08.06.88 |
| Mn (tot) (mg/L) | mg/L | 0.04 | 0.16 | 0.09 | 7 | 05.05.92 | 17.11.97 |
| N (sum sol ox) {$NO_x$-N, TON} | mg/L | 0.00 | 11.62 | 1.06 | 15 | 09.06.94 | 14.10.98 |
| N (tot kjel) | mg/L | 0.70 | 2.30 | 1.11 | 15 | 09.06.94 | 31.07.96 |
| N (tot) {TN, pTN} | mg/L | 0.72 | 12.51 | 2.19 | 12 | 14.09.94 | 31.07.96 |
| $NH_3$-N/$NH_4$-N (sol) | mg/L | 0.01 | 0.24 | 0.07 | 13 | 09.06.94 | 13.12.95 |
| $NO_2$-N (sol) | mg/L | 0.01 | 0.04 | 0.02 | 2 | 11.10.94 | 23.05.95 |
| $NO_3$ (sol) | mg/L | 1.00 | 21.00 | 4.31 | 32 | 03.06.81 | 08.06.88 |
| Na (sol) | mg/L | 134.00 | 2670.00 | 1494.63 | 32 | 03.06.81 | 08.06.88 |
| O - DO% | % | 85.10 | 85.10 | 85.10 | 1 | 23.09.03 | 23.09.03 |
| O - DO | mg/L | 8.40 | 9.30 | 8.85 | 2 | 14.10.98 | 23.09.03 |
| P (tot) {TP, pTP} | mg/L | 0.01 | 0.15 | 0.05 | 14 | 09.06.94 | 14.10.98 |
| $PO_4$-P (sol react) {SRP, FRP} | mg/L | 0.00 | 0.05 | 0.01 | 13 | 09.06.94 | 13.12.95 |
| $SO_4$ (tot) (mg/L) | mg/L | 30.00 | 327.00 | 178.34 | 32 | 03.06.81 | 08.06.88 |
| $SiO_2$ (sol react) | mg/L | 3.00 | 28.00 | 10.59 | 32 | 03.06.81 | 08.06.88 |
| Suspended solids (EDI) | mg/L | 20.38 | 20.85 | 20.62 | 2 | 21.08.75 | 24.08.76 |
| Suspended solids (ETR) | mg/L | 8.72 | 98.48 | 39.31 | 8 | 26.06.75 | 28.07.76 |
| Suspended solids < 63µ (EDI) | % | 284.70 | 284.70 | 284.70 | 1 | 21.01.82 | 21.01.82 |
| Suspended solids < 63µ (gulp) | mg/L | 4.83 | 452.53 | 52.89 | 12 | 10.08.77 | 31.07.86 |
| Suspended solids < 63µ (pump) | mg/L | 3.16 | 583.85 | 237.52 | 41 | 27.07.85 | 21.09.90 |
| Suspended solids < 63µ (EDI) | mg/L | 10.10 | 10.10 | 10.10 | 1 | 21.01.82 | 21.01.82 |
| Suspended solids < 63µ (gulp) | mg/L | 0.11 | 22.28 | 6.21 | 4 | 28.06.78 | 17.08.78 |
| TDSalts (sum of ions) | mg/L | 538.00 | 9610.00 | 5522.28 | 32 | 03.06.81 | 08.06.88 |
| TDSolids (calc @180°C-by cond) | mg/L | 1572.00 | 16524.00 | 7794.28 | 32 | 18.11.69 | 24.08.76 |
| Turbidity (JCU) | JTU | 25.00 | 25.00 | 25.00 | 29 | 18.11.69 | 24.08.76 |
| Turbidity (NTU) | NTU | 0.40 | 188.00 | 9.56 | 1478 | 19.07.78 | 21.05.99 |
| Water level (SLE) | m | 9.92 | 14.07 | 10.44 | 386 | 12.07.66 | 14.10.98 |
| Water temperature (in situ) | deg C | 6.10 | 36.70 | 15.14 | 342 | 30.05.67 | 23.09.03 |
| Water temperature (test) | deg C | 13.00 | 26.30 | 24.70 | 1644 | 04.04.73 | 21.05.99 |
| pH | none | 6.40 | 8.60 | 7.66 | 234 | 18.11.69 | 23.09.03 |
| pH (in situ) | none | 7.60 | 7.80 | 7.70 | 2 | 23.11.83 | 14.10.98 |

*Table A4.2. Department of Environment: Station 615027 – Dale River – Waterhatch Road*

| Parameter | Unit | Minimum | Maximum | Average | Number of readings | First reading | Last reading |
|---|---|---|---|---|---|---|---|
| Acidity ($CaCO_3$) | mg/L | 4.55 | 4.55 | 4.55 | 1 | 27.01.00 | 27.01.00 |
| Al (sol) | mg/L | 0.10 | 0.20 | 0.15 | 2 | 09.05.02 | 07.07.04 |
| Al (tot) | mg/L | 0.10 | 0.10 | 0.10 | 1 | 24.11.97 | 24.11.97 |
| Alkalinity (CO3-$CaCO_3$) | mg/L | 1.00 | 1.00 | 1.00 | 1 | 27.01.00 | 27.01.00 |
| Alkalinity (HCO3-$CaCO_3$) | mg/L | 88.00 | 88.00 | 88.00 | 1 | 27.01.00 | 27.01.00 |
| Alkalinity (tot) ($CaCO_3$) | mg/L | 130.00 | 180.00 | 155.00 | 2 | 09.05.02 | 07.07.04 |
| C (sol org) {DOC} | mg/L | 20.00 | 20.00 | 20.00 | 1 | 27.01.00 | 27.01.00 |
| Ca (sol) | mg/L | 78.00 | 160.00 | 119.33 | 3 | 27.01.00 | 07.07.04 |
| Cl (sol) | mg/L | 2200.00 | 4400.00 | 3566.67 | 3 | 27.01.00 | 07.07.04 |
| Colour (TCU) | none | 82.00 | 130.00 | 103.33 | 3 | 01.09.99 | 27.01.00 |
| Colour (true) | Hu | 28.00 | 50.00 | 35.00 | 4 | 24.11.97 | 02.02.99 |
| Cond comp 25°C (lab) | µs/m | 910000.00 | 1400000.00 | 1242000.00 | 5 | 09.05.02 | 29.04.05 |
| Cond uncomp (in situ) | µs/m | 9470.00 | | 2794923.78 | 45 | 21.04.98 | 02.06.05 |
| Cond uncomp (lab) | µs/m | 203000.00 | 1300000.00 | 735900.00 | 10 | 24.11.97 | 29.04.05 |
| F (sol) | mg/L | 0.40 | 0.50 | 0.45 | 2 | 09.05.02 | 07.07.04 |
| Fe (sol) | mg/L | 0.05 | 0.10 | 0.08 | 2 | 09.05.02 | 07.07.04 |
| Fe (tot) | mg/L | 0.29 | 0.72 | 0.48 | 4 | 24.11.97 | 27.01.00 |
| K (sol) | mg/L | 10.00 | 18.00 | 14.33 | 3 | 27.01.00 | 07.07.04 |
| Mg (sol) | mg/L | 210.00 | 510.00 | 376.67 | 3 | 27.01.00 | 07.07.04 |
| Mn (sol) | mg/L | 0.05 | 0.05 | 0.05 | 2 | 09.05.02 | 07.07.04 |
| Mn (tot) | mg/L | 0.05 | 0.13 | 0.08 | 4 | 24.11.97 | 27.01.00 |
| N (sum sol ox) {$NO_x$-N, TON} | mg/L | 0.00 | 2.10 | 0.17 | 27 | 21.04.98 | 07.07.04 |
| N (tot kjel) | mg/L | 0.15 | 1.05 | 0.74 | 24 | 21.04.98 | 02.06.04 |
| N (tot) {TN, pTN} | mg/L | 0.52 | 3.20 | 1.02 | 57 | 21.04.98 | 02.06.05 |
| $NH_3$-N/NH4-N (sol) | mg/L | 0.01 | 0.08 | 0.03 | 22 | 23.10.02 | 02.06.04 |
| $NO_2$-N (sol) | mg/L | 0.01 | 0.04 | 0.01 | 24 | 23.10.02 | 07.07.04 |
| $NO_2$-N (tot) | mg/L | 0.01 | 0.01 | 0.01 | 1 | 09.05.02 | 09.05.02 |
| $NO_3$ (sol) | mg/L | 1.70 | 1.70 | 1.70 | 1 | 27.01.00 | 27.01.00 |
| $NO_3$-N (tot) | mg/L | 0.01 | 0.01 | 0.01 | 1 | 09.05.02 | 09.05.02 |
| Na (sol) | mg/L | 1100.00 | 2200.00 | 1766.67 | 3 | 27.01.00 | 07.07.04 |
| O - DO% | % | 30.30 | 116.40 | 81.44 | 13 | 23.10.02 | 02.06.05 |
| O - DO (in situ) | mg/L | 2.70 | 12.59 | 7.83 | 34 | 01.09.99 | 02.06.05 |
| O - DO | mg/L | 8.20 | 13.00 | 9.96 | 9 | 27.08.98 | 23.09.03 |
| P (tot) {TP, pTP} | mg/L | 0.01 | 0.33 | 0.04 | 59 | 21.04.98 | 02.06.05 |
| $PO_4$-P (sol react) {SRP, FRP} | mg/L | 0.00 | 0.01 | 0.00 | 22 | 23.10.02 | 02.06.04 |
| $SO_4$ (sol) | mg/L | 170.00 | 250.00 | 210.00 | 2 | 27.01.00 | 09.05.02 |
| $SO_4$ (tot) | mg/L | 110.00 | 110.00 | 110.00 | 1 | 07.07.04 | 07.07.04 |
| Salinity | mg/L | 6500.00 | 6500.00 | 6500.00 | 1 | 21.10.04 | 21.10.04 |
| $SiO_2$ (sol react) | mg/L | 5.10 | 5.10 | 5.10 | 1 | 09.05.02 | 09.05.02 |
| $SiO_2$-Si (sol react) | mg/L | 7.80 | 9.40 | 8.53 | 3 | 27.01.00 | 07.07.04 |
| Suspended solids (EDI) | mg/L | 1.20 | 28.00 | 8.01 | 18 | 02.06.05 | 12.07.00 |
| Turbidity (JCU) | JTU | 1.00 | 14.00 | 4.51 | 16 | 02.06.05 | 21.04.98 |
| Water level (AHD) | m | 10.60 | 10.60 | 10.60 | 1 | 02.06.05 | 02.06.05 |
| Water level (SLE) | m | 9.90 | 11.42 | 10.52 | 41 | 24.11.97 | 29.04.05 |
| Water temperature (in situ) | deg C | 9.70 | 32.10 | 18.30 | 46 | 24.11.97 | 02.06.05 |
| Water temperature (test) | deg C | 17.80 | 25.10 | 22.89 | 11 | 24.11.97 | 02.06.05 |
| pH | none | 6.90 | 8.50 | 7.96 | 44 | 24.11.97 | 02.06.05 |
| pH (in situ) | none | 7.70 | 8.40 | 8.06 | 10 | 27.08.98 | 12.07.01 |

# Appendix 5
# Foreshore and Channel Condition Assessment Form

**For property and paddock scale surveys**

## General Details

Recorder's Name: …….. Survey Date: ……

Tributary Name: ……. Section Number: …….

Catchment Name: …….. Length of Section: ……...

Sub-catchment Name: ……... Shire: ……

Nearest Road Intersection: ……..

GPS (start of survey section) E: ……..…… N:…..……

GPS (end of survey section) E: …….. N: ……

Landholder contacted: Yes ❒ No ❒ Bank(s) surveyed (facing upstream)

Landholder consent obtained: Yes ❒ No ❒ left ❒ right ❒ both ❒

Landholder present during survey: Yes ❒ No ❒

Landholder: …….. Contact Number: .....

Property address: …….

## Bank Stability

| Proportion of bank affected (% of survey area) | Undercutting | Firebreak/track washouts | Subsidence (sinking of soil) | Erosion | Gully erosion | Sedimentation | Slumping (mass movement) |
|---|---|---|---|---|---|---|---|
| 0-5% Minimal | | | | | | | |
| 5-20% Localised | | | | | | | |
| 20-50% Significant | | | | | | | |
| >50% Severe | | | | | | | |

Are the banks subject to any artificial stabilisation?: ❒ Yes ❒ No

Give details:

## Waterways Features

❒ Single channel
❒ Braided channel
❒ Deep pool
❒ Wetlands
❒ Other
……

❒ Dam
❒ Groundwater
❒ Riffles (natural)
❒ Anabranch
❒ Tributary
❒ Large woody debris

❒ Riffles (artificial)
❒ Bridge
❒ Sand slugs
❒ Vegetated islands

## Vegetation Health

❒ Looks healthy ❒ Some sick trees (some foliage loss) ❒ Many sick or dying trees ❒ Some dead trees ❒ Many dead trees

Are there any tree seedlings or saplings present?: ❒ Yes ❒ No Species: ……

Leaf litter: ❒ Absent ❒ Minimal cover ❒ Good cover ❒ Deep cover

Bare Ground: % cover: ……

Native vegetation: ❒ Abundant ❒ Frequent ❒ Occasional ❒ Rare ❒ Absent

Exotic vegetation: ❒ Abundant ❒ Frequent ❒ Occasional ❒ Rare ❒ Absent

Instream cover: ❒ Leaf litter/detritus ❒ Rocks ❒ Branches ❒ Vegetation

### Vegetation cover (Native and weeds)

| Proportion cover | Overstorey | Middlestorey | Understorey |
|---|---|---|---|
| > 80% Continuous | | | |
| 20-80% Patchy | | | |
| < 20% Sparse | | | |
| 0% Absent | | | |

### Proportion of Native Species

| | Proportion (%) of native species |
|---|---|
| Overstorey | |
| Middlestorey | |
| Understorey | |

## Habitats

**Aquatic organisms**
**Invertebrates, reptiles and fish**
❒ Cascades, rapids, riffles
❒ Meanders, pools
❒ Instream cobbles, rocks
❒ Instream logs
❒ Variety of instream and bank vegetation types

**Terrestrial animals**
**Invertebrates**
❒ Variety of vegetation types
❒ Protected basking sites (tree bark, leaf litter)

**Birds (roosting/nesting sites)**
❒ Trees
❒ Shrubs
❒ Rushes

**Frogs**
❒ Dense streamside vegetation
❒ Emergent plants/soft substrate for eggs

**Reptiles**
❒ Variety of vegetation types
❒ Protected basking/nesting sites (leaf litter, logs)

**Mammals**
❒ Dense protective vegetation

## Habitat Diversity

Any data or observations on variation in water depth? Evidence – debris, water marks, salt deposits etc

Any data or observations on water quality? (i.e. discoloured water, debris, algal blooms)

Any wildlife (or evidence of presence) observed?

## Landform Types

**Description/Diagram** (i.e. major v-shaped river valley with granite outcrops, shallow valley with low relief).

**Fencing Status**

**Left Bank**

Fence present? ❒ Yes ❒ No Fence condition: ❒ Good ❒ Moderate ❒ Poor

Fence style: ❒ Barbed wire ❒ Electric ❒ Fabricated ❒ Ringlock ❒ Plain wire

**Right Bank**

Fence present? ❒ Yes ❒ No Fence condition: ❒ Good ❒ Moderate ❒ Poor

Fence style: ❒ Barbed wire ❒ Electric ❒ Fabricated ❒ Ringlock ❒ Plain wire

Fence position (approximate distance [m] from river bank): LB: ……..….. RB: .....

Stock access to foreshore: ❒ Yes ❒ No Vehicle access to foreshore: ❒ Yes ❒ No

Crossing Point: ❒ Yes ❒ No

## Foreshore Condition Assessment

| 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 |

(Choose one of the above. Use Grades A, B, C or D for General condition and use sub-grades for best and poorest ratings ie A1 through to D3)

General: Best: Poorest:

## Overall Stream Environmental Rating

| Rating | Floodway & bank vegetation | Verge vegetation | Stream Cover | Bank stability & 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 landuse:

Conservation reserve (8) Urban (2) Agricultural (2)

Rural residential (4) Remnant bush (6) Commercial/industrial (1)

Total score = ☐

| **Score** | 40-55 | 30-39 | 20-29 | 10-19 | 0-9 |
|---|---|---|---|---|---|
| **Rating** | Excellent | Good | Moderate | Poor | Very poor |

Environmental rating = …….

## Evidence of Management

Tick the appropriate boxes:

❒ Prescribed burning
❒ Firebreak control
❒ Fencing
❒ Nest boxes
❒ Recreational facilities (e.g. rubbish bins, BBQ's, benches)
❒ Signs
❒ Planting
❒ Weed control
❒ Erosion control
❒ Earthworks
❒ Sediment management

❒ Other: .....

## Management Issues

Tick the appropriate priority box for each management issue. If the issue does not exist along this section of the waterway it can be crossed out.

| *Issue* | *Priority* | | |
|---|---|---|---|
| | **High** | **Medium** | **Low** |
| Fire | | | |
| Disease | | | |
| Weeds | | | |
| Erosion | | | |
| Salinity | | | |
| Sediment | | | |
| Stock Access | | | |
| Vehicle Access | | | |
| Rubbish | | | |
| Pollution | | | |

| *Issue* | *Priority* | | |
|---|---|---|---|
| | **High** | **Medium** | **Low** |
| Recreation | | | |
| Garden Refuse | | | |
| Service Corridors (roads) | | | |
| Crossing point | | | |
| Feral Animals | | | |
| Point source discharge | | | |
| Pumps or off-take pipes | | | |
| Dam/weir | | | |
| Cultural Features | | | |

## Ideas for Management

Tick the appropriate boxes:

❒ Prescribed burning
❒ Firebreak control
❒ Fencing
❒ Erosion control
❒ Recreational facilities (e.g. rubbish bins, BBQ's, benches)
❒ Stock crossing
❒ Planting
❒ Weed control
❒ Earthworks/riffles
❒ Sediment management

❒ Other: .....

## Vegetation

| **Plant Name** | **Abundance (H,M,L)** | ***Plant Name*** | **Abundance (H,M,L)** |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

## Water Quality Data

| Sample Number | pH | Conductivity mS/cm | Temperature ºC | Location |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

## GPS Coordinates

| Coordinate | Description |
|---|---|
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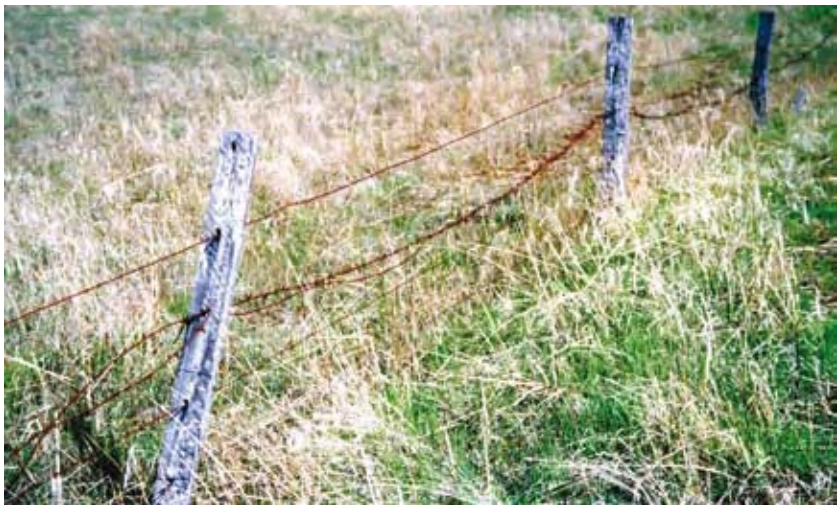
## Photos

# Appendix 6 Examples of fence condition ratings



*Fence condition*: POOR.

*Fence condition*: MODERATE.

*Fence condition*: GOOD.

# Appendix 7 Overall foreshore condition ratings

### A-Grade

*Foreshore has healthy native bush (ie similar to that found in nature reserves, state forests and national parks).*

**A1. Pristine** – river embankments and floodway are entirely vegetated with native species and there is no evidence of human presence or livestock damage.

**A2. Near Pristine** – Native vegetation dominates. Some introduced weeds may be present in the understorey but not as the dominant species. Otherwise, there is no evidence of human impact.

**A3. Slightly Degraded** – Native vegetation dominates. Some areas of human disturbance where soil may be exposed and weeds are relatively dense (ie along tracks). Native vegetation would quickly recolonise if human disturbance declined.

### B-Grade

*The foreshore vegetation had been invaded by weeds, mainly grasses and looks similar to typical roadside vegetation.*

**B1. Degraded** – weed infested – Weeds have become a significant component of the understorey vegetation. Native species are still dominant but a few have been replace by weeds.

**B2. Degraded** – heavily weed infested – Understorey weeds are nearly as abundant as native species. The regeneration of trees and large shrubs may have declined.

**B3. Degraded** – weed dominant – Weeds dominate the understorey, but many native species remain. Some trees and large shrubs may have disappeared.

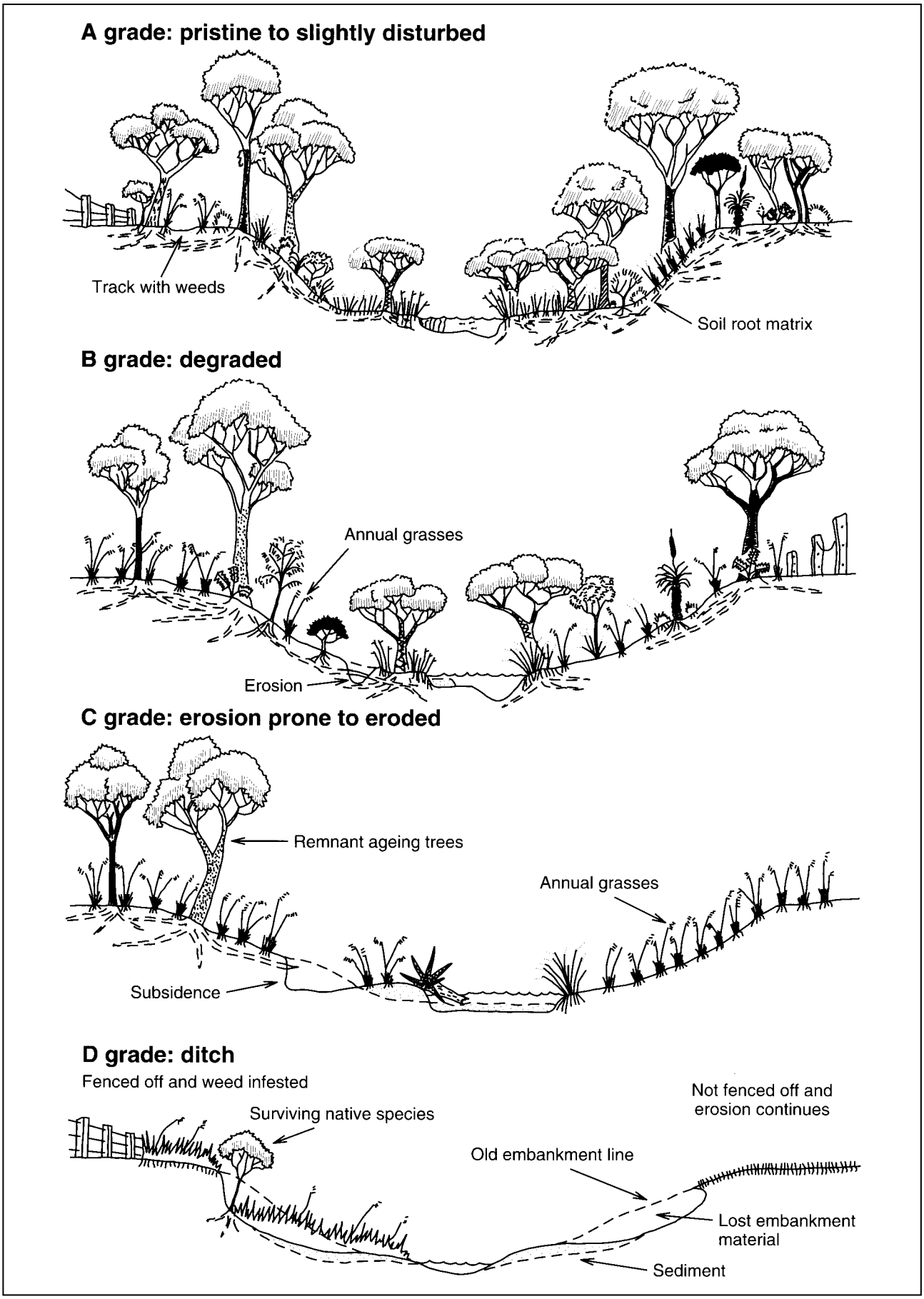
### C-Grade

*The foreshore supports only trees over weeds or pasture. Bank erosion and subsidence may occur in localised areas.*

C1. Erosion prone – Trees remain with some large shrubs or tree grasses and the understorey consists entirely of weeds (ie annual grasses). There is little or no evidence of regeneration of tree species. River embankment and floodway are vulnerable to erosion due to the shallow-rooted weedy understorey providing minimal soil stabilisation and support.

C2. Soil exposed – Older trees remain but the ground is virtually bare. Annual grasses and other weeds have been removed by livestock grazing and trampling or through humans use and activity. Low level soil erosion has begun.

C3. Eroded – Soil is washed away from between tree roots. Trees are being undermined and unsupported embankments are subsiding into the river valley.




*Source: Water and Rivers Commission, 1999*

### D-Grade

*The stream is little more than an eroding ditch or a weed infested drain.*

**D1. Ditch** – **eroding** – There is not enough fringing vegetation to control erosion. Remaining trees and shrubs act to impede erosion in some areas, but are doomed to be undermined eventually.

**D2. Ditch** – **freely eroding** – No significant fringing vegetation remains and erosion is out of control. Undermined and subsided embankments are common. Large sediment plumes are visible along the river channel.

**D3. Drain** – **weed dominant** – The highly eroded river valley has been fenced off, preventing control of weeds by stock. Perennial weeds have become established and the river has become a simple drain.

# Appendix 8 Overall Environmental Stream Health Rating

*Table A8.1: Factors and scoring for determining the overall environmental health rating (adapted from Water and Rivers Commission, 1999)*

| | Floodway and bank vegetation | Verge vegetation | Stream cover | Bank stability and sedimentation | Habitat diversity |
|---|---|---|---|---|---|
| **Excellent** | Healthy undisturbed native vegetation. Virtually no weeds. No disturbance.<br>**(15 points)** | Healthy undisturbed vegetation. Verges more than 20 m wide.<br>**(8 points)** | Abundant cover: shade, overhanging vegetation, snags, leaf litter, rocks and/or aquatic vegetation.<br>**(8 points)** | No erosion, subsidence or sediment deposits. Dense vegetation cover of banks and verge. No disturbance.<br>**(8 points)** | 3 or more habitat zones.<br>Some permanent water<br>**(6 points)** |
| **Good** | Mainly healthy undisturbed native vegetation. Some weeds.<br>No recent disturbance.<br>**(12 points)** | Mainly healthy undisturbed native vegetation. Verges less than 20 m wide.<br>**(6 points)** | Abundant shade and overhanging vegetation. Some instream cover.<br>**(6 points)** | No significant erosion, subsidence or sediment deposits in floodway or on lower banks. May be some soil exposure and vegetation thinning on upper bank and verge.<br>**(6 points)** | 2 habitat zones.<br>Some permanent water.<br>**(4 points)** |
| **Moderate** | Good vegetation cover, but mixture of native and exotic species. Localised clearing. Little recent disturbance.<br>**(6 points)** | Good vegetation cover, but mixture of native and exotic species. Verges 2 or more.<br>**(4 points)** | Some permanent shade and overhanging vegetation. Some instream cover.<br>**(4 points)** | Good vegetation cover.<br>Localised erosion, bank collapse and sediment heaps only. Verges may have sparse vegetation cover.<br>**(4 points)** | Mainly 1 habitat type with permanent water.<br>OR<br>Range of habitats with no permanent water.<br>**(2 points)** |
| **Poor** | Mainly exotic ground cover. Obvious site disturbance.<br>**(3 points)** | Narrow verges only (< 20 m wide). Mainly exotic vegetation.<br>**(2 points)** | Channel mainly clear.<br>Little permanent shade or instream cover.<br>**(2 points)** | Extensive active erosion and sediment heaps. Bare banks and verges common.<br>Banks may be collapsing.<br>**(2 points)** | Mainly 1 habitat type with no permanent water.<br>**(1 point)** |
| **Very Poor** | Mostly bare ground or exotic ground covers (ie pasture, gardens or weed infestations, but no trees).<br>**(0 points)** | Mostly bare ground or exotic ground covers (ie pasture, gardens or weed infestations, but no trees).<br>**(0 points)** | Virtually no shade or instream cover.<br>**(0 points)** | Almost continuous erosion.<br>Over 50% of banks collapsing. Sediment heaps line or fill much of the floodway. Little or no vegetation cover.<br>**(0 points)** | Stream channellised.<br>**(0 points)** |

**Scores for surrounding landuse:**

| | | |
|---|---|---|
| Conservation reserve **(8 points)** | Rural residential **(4 points)** | Agricultural **(2 points)** |
| Remnant bush **(6 points)** | Urban **(2 points)** | Commercial/industrial **(2 points)** |

# Appendix 9 Flora and fauna lists

*Table A9.1. Native plant species identified during the Dale River foreshore assessment*

| Common name | Scientific name |
|---|---|
| Tree | |
| Flooded gum | *Eucalyptus rudis* |
| Jarrah | *Eucalyptus marginata* |
| Marri | *Corymbia calophylla* |
| Rock sheoak | *Allocasurina hugeliana* |
| Salmon gum | *Eucalyptus salmonphloia* |
| Swamp banksia | *Banksia littoralia* |
| Swamp paperbark | *Melaleuca rhaphiophylla* |
| Swamp sheoak | *Casuarina obesa* |
| Wandoo | *Eucalyptus wandoo* |
| York gum | *Eucalyptus loxophelba* sub. *loxophelba* |
| **Shrub** | |
| A blood root | *Haemodorum spp* |
| Astartea | *Astartea fascicularis* |
| Dune moses | *Acacia lasiocarpa* |
| Fuchsia grevillea | *Grevillea bipinnatifida* |
| Golden wreath wattle | *Acacia saligna* |
| Grass tree | *Zanthorrhoea preissii* |
| Green stinkwood | *Jacksonia sternbergiana* |
| Grey stinkwood | *Jacksonia furcellata* |
| Harsh hakea | *Hakea prostrata* |
| Jam wattle | *Acacia acuminata* |
| Manna wattle | *Acacia microbotrya* |
| Mohan | *Melaleuca viminea* sub *viminea* |
| Needlebush | *Hakea pressii* |
| Robin redbreast bush | *Melaleuca lateritia* |
| Swamp teatree | *Pericalymma ellipticum* |
| Two-leaf hakea | *Hakea trifurcata* |
| Variable-leaved hakea | *Hakea varia* |
| Water bush | *Bossiaea aquifolium* |
| White myrtle | *Hypocalymma angustifolium* |
| **Mistletoe** | |
| Stalked mistletoe | *Amyema miquelii* |
| Wireleaf mistletoe | *Amyema preissii* |
| **Groundcover** | |
| A fringed lily | *Thysanotus spp* |
| A samphire | *Halosarcia* spp |
| An Iris | *Patersonia* spp |
| Coast bonefruit | *Threlkeldia diffusa* |
| Couch honeypot | *Dryandra lindleyana* |
| Creeping saltbush | *Atriplex semibaccata* |
| Native buttercup | *Hibbertia* spp |
| Native flax | *Dianella* spp |
| Native violet | *Hybanthus floribundus* |
| Sea heath | *Frankenia pauciflora* |
| **Herb** | |
| A sundew | *Drosera* spp |
| Angled lobelia | *Lobelia alata* |
| Creeping monkey flower | *Mimulus repens* |
| **Rushes and sedges** | |
| A rush | *Restionacea* spp |
| A rush | *Restionacea* spp |
| A rush | *Shoenus* spp |
| A sedge | *Desmocladus flexuosus* |
| Bare twigrush | *Baumea juncea* |
| Black bristlerush | *Chorizandra enodis* |
| Bulrush | *Typha domingensis* |
| Finger rush | *Juncus subsecundus* |
| Jointed twigrush | *Baumea articulata* |
| Pale rush | *Juncus pallidus* |
| Pithy sword sedge | *Lepidosperma longitudinale* |
| Shore rush | *Juncus krausii* |
| Spiny flat sedge | *Cyperus gymnocaulos* |
| **Grass** | |
| Featherspear grass | *Austrostipa elantissima* |
| Kerosene grass | *Aristida holathera* |
| Native marine couch | *Sporobolus virginicus* |
| **Aquatic** | |
| | *Lepilaena* spp |
| Water ribbons | *Triglochin* spp |

*Table A9.2: Introduced plant species identified during the Dale River foreshore assessment*

| Common name | Scientific name |
|---|---|
| **Tree** | |
| Almond | *Prunus dulcis* |
| Cootamundra wattle | *Acacia baileyana* |
| Japanese pepper | *Schinus terebinthifolia* |
| Mulberry tree | *Morus* spp |
| Tamarisk | *Tamarix* spp |
| **Herb** | |
| A bulb | *Unknown* |
| A clover | *Trifolium* spp |
| Capeweed | *Arctotheca calendula* |
| Corkscrew | *Erodium botrys* |
| Dock | *Rumex* spp |
| Finger leaf oxalis | *Oxalis glabra* |
| Flatweed | *Hypochaeris* spp |
| Flaxleaf fleabane | *Conyza bonariensis* |
| Four o'clock | *Oxalis purpurea* |
| Gazania | *Gazania linearis* |
| Guildford grass | *Romulea rosea* |
| Narrowleaf lupin | *Lupinus angustifolius* |
| Nightshade | *Solanum* spp |
| One-leaf cape tulip | *Homeria flaccida* |
| Onion weed | *Asphodelus fistulosus* |
| Pie melon | *Citrullus lanatus* |
| Prickly lettuce | *Lactuca serriola* |
| Smooth heliotrope | *Heliotropium curassavicum* |
| Soursob | *Oxalis pes-caprae* |
| Stinkwort | *Dittrichia graveolens* |
| Waterbuttons | *Cotula coronopifolia* |
| Wire weed | *Polygonum aviculare* |
| | *Atriplex prostrata* |
| **Creeper** | |
| Bridal creeper | *Asparagus asparagoides* |
| **Grass** | |
| A Fescue | *Vulpia* spp |
| Barley grass | *Hordeum leporinum* |
| Blowfly grass | *Briza maxima* |
| Brome grass | *Bromus* spp |
| Foxtail grass | *Alopecurus* sp |
| Love grass | *Eragrostis* spp |
| Perennial veldt grass | *Ehrharta calycina* |
| Puccinellia | *Puccinellia ciliata* |
| Salt-water couch | *Paspalum vaginatum* |
| Wild oats | *Avena fatua* |
| **Rushes and sedges** | |
| Bulrush | *Typha ocrientalis* |
| Spike rush | *Juncus acutus* |

*Table A9.3: Fauna identified during the Dale River foreshore assessment*

| Common name | Scientific name |
|---|---|
| **Native mammals** | |
| Brushtail possum | *Trichosurus vulpecula* |
| Western grey kangaroo | *Macropus fuliginosus* |
| **Feral mammals** | |
| European red fox | *Vulpes vulpes* |
| European wild rabbit | *Oryctolagus cuniculus* |
| Feral cat | *Felis catus* |
| Feral pig | *Sus scrofa* |
| **Insects** | |
| Honey bees | *Apis mellifera* |
| Spider spp | |
| Moth spp | |
| Ants spp | |
| Whirlygig beetle | Coleoptera spp |
| Bullant spp | |
| Grasshopper spp | |
| Wasp spp | |
| Ladybug spp | |
| Butterfly spp | |
| Lerp spp | |
| Water flea | *Cladocera* spp |
| **Fish** | |
| Mosquito fish (introduced) | *Gambusia holbrooki* |
| Western hardyhead | *Leptatherine wallacei* |
| Western minnow | *Galaxias occidentalis* |
| **Crustaceans** | |
| Gilgie | *Cherax* spp |
| **Reptiles** | |
| Fence skink | *Acritoscincus trilineatum* |
| Long-necked tortoise | *Chelodina oblonga* |

*Table A9.4: Fungi identified during the Dale River foreshore assessment*

| Common name | Scientific name |
|---|---|
| A puffball | Possibly *Lycoperdon* spp |
| A bracket fungi ('Orange Peel Fungi') | *Pycnoporus coccineus* |
| A bracket fungi | Possibly *Pitoporrus portentosus* |
| A mushroom | *Agaricus* spp |
| | *Boletus* spp |
| Unidentified fungi | 4 species |

*Table 9.5: Bird species identified during the Dale River foreshore assessment*

| Common name | Scientific name | Habitat type* | Conservation Status* |
|---|---|---|---|
| Australasian Grebe | *Tachybaptus novaellandiae* | | |
| Australian Magpie | *Gymnorhina tibicen* | Woodland | Farmland |
| Australian Magpie-lark | *Grallina cyanoleuca* | Woodland | Farmland |
| Australian Raven | *Corvus coronoides* | Farmland | Farmland |
| Australian Ringneck | *Barnardius zonarius* race *zonarius* | Farmland | Farmland |
| Australian Shelduck | *Tadorna tadornoidies* | Farmland | Farmland |
| Australian White Ibis | *Threskiornis molucca* | | |
| Australian Wood Duck | *Chenonetta jubata* | Farmland | Farmland |
| Barn Owl | *Tyto alba* | Farmland | Farmland |
| Black Swan | *Cygnus atratus* | | |
| Black-faced cuckoo-shrike | *Coracina novaehollandiae* | Woodland | Farmland |
| Black-fronted Dotterol | *Elseyornis melanops* | | |
| Black-shouldered Kite | *Elanus notatus* | | |
| Crested Pigeon | *Ocyphaps lophotes* | Farmland | Farmland |
| Dusky Moorhen | *Gallinula tenebrosa* | | |
| Dusky Woodswallow | *Artamus cyanopterus* | | |
| Eurasian Coot | *Fulica atra* | | |
| Galah | *Eolophus roseicapilla* | Woodland | Farmland |
| Golden Whistler | *Pachycephala pectoralis* | | |
| Great Egret | *Ardea alba* | | |
| Grey Fantail | *Rhipidura fuliginosa* | Woodland | Remnant Dependant |
| Grey Teal | *Anas gracilis* | Farmland | Farmland |
| Grey-shrike thrush | *Colluricincla harmonica* | Woodland | Remnant Dependant |
| Hardhead | *Aythya australis* | | |
| Inland thornbill | *Acanthiza pursilla* | Shrubland | Priority |
| Laughing Kookaburra | *Dacelo novaeguineae* | | |
| Laughing Turtledove | *Streptopelia senegalensis* | | |
| Little Pied Cormorant | *Phalacrocorax varius* | | |
| Little Western Wattlebird | *Anthochaera lunulata* | | |
| Martin spp | *Hirundo* spp | Farmland | Farmland |
| Mistletoebird | *Dicaeum hirundinaceum* | | |
| Nankeen Night Heron | *Nycticorax caledonicus* | | |
| Pacific Black Duck | *Anas superciliosa* | | |
| Pied Butcherbird | *Cracticus nigrogularis* | Woodland | Farmland |
| Red Wattlebird | *Anthochaera carunculata* | Woodland | Remnant Dependant |
| Red-capped Parrot | *Purpureicephalus spurius* | | |
| Red-capped Robin | *Petroica goodenovii* | Woodland | Priority |
| Rufous Treecreeper | *Climacteris picumnus* | Woodland | Priority |
| Rufous Whistler | *Pachycephala rufiventris* | Woodland | Priority |
| Scarlet Robin | *Petroica multicolor* | | |
| Silvereye | *Zosterops luteus race chloronotos* | | |
| Singing Honeyeater | *Lichenostomus virescens* | Shrubland | Remnant Dependant |
| Splendid Fairy-wren | *Malurus splendens* | | |
| Spotted Pardolote | *Pardalotus punctatus* | | |
| Stubble Quail | *Coturnix pectoralis* | Farmland | Farmland |
| Varied Sittella | *Daphoenositta chrysoptera* | Woodland | Priority |
| Wedge-tailed Eagle | *Aquila audax* | | |
| Weebill | *Smicronis brevirostris* race *occidentalis* | Woodland | Remnant Dependant |
| Welcome Swallow | *Hirundo neoxena* | Farmland | Farmland |
| Western Gerygone | *Gerygone fusca* | Farmland | Remnant Dependant |
| Western Thornbill | *Acanthiza inornata* | | |
| Western Yellow Robin | *Eopsaltria griseogularis* | Shrubland | Priority |
| Whistling Kite | *Haliastur sphenurus* | | |
| White-faced Heron | *Egretta novaehollandiae* | Farmland | Farmland |
| Willie Wagtail | *Rhipidura leucophrys* | Woodland | Farmland |
| Yellow-billed Spoonbill | *Platalea flavipes* | | |
| Yellow-rumped Thornbill | *Acanthiza chrysorrhoa* | Woodland | Remnant Dependant |

*Source: Greening Australia Western Australia, 2004

*Table 9.6: Beverley Naturalists' Flora list 2006*

| Scientific name | Common name | Location |
|---|---|---|
| *Calothamnus brevifolius* | | Dale-Kokeby roadside |
| *Centaurium spicatum* | spike centuary | Dale-Kokeby roadside |
| *Clematis delicata* | | Dale-Kokeby roadside |
| *Dichopogon capilles* | | Dale-Kokeby roadside |
| *Dryandra sessilis* | parrot bush | Dale-Kokeby roadside |
| *Grevillea eriostachya* | flame grevillia | Westdale (private property) |
| *Hibbertia commutata* | | Westdale (private property) |
| *Hibbertia hypericoides* | yellow buttercups | Westdale (private property) |
| *Jacksonia epiphyllum* | | Dale-Kokeby roadside |
| *Kennedia prostrata* | scarlet runner | Westdale (private property) |
| *Lechenaultia biloba* | blue lechnaultia | Westdale (private property) |
| *Lysinema ciliatum* | central wheatbelt lysinema | Westdale (private property) |
| *Melaleuca tuberculata* var. *tuberculata* | | Westdale (private property) |
| *Microcorys ericifolia* | | Westdale (private property) |
| *Monotaxis grandiflora* var. *grandiflora* | diamond of the desert | Westdale (private property) |
| *Nuytsia floribunda* | christmas tree | Dale-Kokeby roadside |
| *Phyllanthus calycinus* | false boronia | Westdale (private property) |
| *Pimelea argentea* | silvery leaved pimelia | Westdale (private property) |
| *Pimelia ciliata* subsp. *ciliata* | | Westdale (private property) |
| *Wahlenbergia gracilenta* | annual bluebell | Dale-Kokeby roadside |
| *Spergularia marina* | | Dale-Kokeby roadside |
| *Ptilotus declinatus* | curved mulla mulla | Dale-Kokeby roadside |
| *Verreauxia* sp *reinwardtii* | | Dale-Kokeby roadside |

# Appendix 10 Plant species suitable for revegetation

*Table 10.1. Native species suitable for revegetation along the Dale River and its tributaries (Oversby, 2004; Water and Rivers Commission, 1997a; Water and Rivers Commission, 1997b)*

| Species | Revegetation tips |
|---|---|
| **Rushes and sedges** | |
| Bare twigrush (*Baumea juncea*) | Prefers light soils with fairly constant moisture along streambanks and floodways. Moderately tolerant to waterlogging and mildly salt tolerant. |
| Coast saw sedge (*Garnia trifida*) | Occurs on most soils types on fresh to saline floodways. Moderately water logging and very salt tolerant. Propagated from creeping stems. |
| Finger rush (*Juncus subsecundus*) | Grows on moist and seasonally wet floodway soils. Can be direct seeded. |
| Jointed twigrush (*Baumea articulata*) | Suitable for heavy and sandy soils on streambanks and floodways. Can withstand prolonged inundation up to 1 m. Transplant using creeping stems. |
| Shore rush (*Juncus krausii*) | Suitable for streambanks, seeps and floodways. Very tolerant to waterlogging and salinity. Easily propagated by seed and by transplanting creeping stems |
| Spiny flat sedge (*Cyperus gymnocaulos*) | Suitable for most soil types on streambanks and seeps, especially in disturbed areas or waterways with high nutrient levels. Moderately salt tolerant but does not tolerate inundation for very long. |
| **Ground cover** | |
| Creeping saltbush/berry saltbush (*Atriplex semibaccata*) | Suitable for a wide variety of fresh to slightly saline soils across the landscape including floodfringes and floodways. Slightly waterlogging and salt tolerant. Can be grown from tubestock or direct seeded. |
| Sea heath (*Frankenia pauciflora*) | Grows in sands and lighter soils in floodways and winter-wet areas. Very salt and waterlogging tolerant. Can be grown from tubestock. |
| **Grasses** | |
| Kerosene grass (*Aristida holathera*) | Grows on sands, loams and gravels on floodfringes and the drier parts of floodways. Does no tolerate waterlogging but is slightly salt tolerant. Can be grown from tubestock or direct seeded. |
| Native marine couch (*Sporobolus virginicus*) | Suitable for lighter soils on streambanks and floodways. Very tolerant to waterlogging ad moderately salt tolerant. Easily propagated by transplanting creeping stems |
| **Shrubs** | |
| Astartea (*Astartea fascicularis*) | Grows on alkaline sands near watercourses, wetlands and seasonally wet depressions. Can be grown from cuttings taken in autumn or direct seeded. |
| Golden wreath wattle (*Acacia saligna*) | Grows on a variety of soil types on floodfringes and floodways. Can be planted from tubestock or direct seeded. Seed needs scarification and heat treatment for uniform germination. |
| Jam wattle (*Acacia acuminata*) | Grows on a variety of soil types, especially red loams, on floodfringes and drier floodways. Slightly waterlogging and salt tolerant. Plant as tubestock or direct seed. Seed needs scarification and heat treatment for uniform germination. |

| Species | Revegetation tips |
|---|---|
| **Shrubs (continued)** | |
| Manna gum (*Acacia microbotrya*) | Occurs on a wide range of soil types on floodways and floodfringes. Slightly waterlogging and salt tolerant. Plant from tubestock or direct seed. Seed needs scarification and heat treatment for uniform germination. |
| Mohan (*Melaleuca viminea* sub. *viminea*) | Grows in a variety of soil types in floodways. Moderately salt and waterlogging tolerant. Can be grown from tubestock or direct seeded. |
| Robin redbreast bush (*Melaleuca lateritia*) | Grows on floodway soils. Can be grown from cuttings and direct seeded. |
| Swamp banksia (*Banksia littoralis*) | Grows within floodfringes but is not tolerant of prolonged waterlogging and inundation. Can be grown readily from seed collected in autumn and late winter and direct seeded. |
| Swamp paperbark (*Melaleuca rhaphiophylla*) | Suitable for a variety of floodway soils. Extremely tolerant of waterlogging and mildly salt tolerant. Plant tubestock or direct seed. |
| Swamp sheoak (*Casuarina obesa*) | Suitable for a variety of floodway soils. Very salt and waterlogging tolerant. Plant tubestock or direct seed. |
| **Trees** | |
| York gum (*Eucalyptus loxophelba* sub. *loxophelba*) | Suitable for a variety of soil types including floodfringes and the drier parts of floodways. Does not tolerate waterlogging or salt. Plant tubestock or direct seed. |
| Flooded gum (*Eucalyptus rudis*) | Suitable for most soil types in winter-wet depressions, floodways and floodfringes. Very tolerant of waterlogging and moderately salt tolerant. Plant tubestock or direct seed. |

# Appendix 11 Avon Waterways Committee fire policy

## Recovery Statement Number 1

## FIRE

### Introduction

The *Avon Waterways Committee* (AWC) is an organisation formed to assist the community and government agencies to sustainably manage the waterways within the Avon River Basin, within a framework of natural resource management. It has a mandate to continue the progression of the *Avon River Management Programme*, developed by its predecessor, the *Avon River Management Authority* (ARMA).

It has resolved to evolve the policies developed by ARMA as a statutory authority into more 'user friendly' position statements, called ***Recovery Statements***, and to develop new statements for issues as they arise.

The AWC, in developing these documents, have agreed that the 'Principles of River Management' written by the late Jim Masters OA, and other sound scientific principals will underpin each Statement. Further, they recognise that each document must be consistent with the Avon Catchment Council's *Natural Resource Management Strategy for the Avon River Basin*.

The following document is a draft *Recovery Statemen*t on '***FIRE***'.

### Objectives

**The long-term objective of Avon Waterways Committee is to restore the natural functioning and vegetation of the Avon River and its major tributaries. Arising out of this aim, the Committee has four objectives related to fire:**

- To protect riverine ecosystems from the damaging effects of uncontrolled fire:
- To use controlled fire for regeneration in accordance with management plans;
- To manage the fire hazard along the river, so as to minimise the threat of wildfire's to adjoining assets and property, and;
- To work cooperatively with Local Governments, Fire Brigades and neighbours with respect to fire management and development of Fire Management Plans.

### Background

Fire is a natural factor in most Australian ecosystems. It can be started by lightning as well as by humans. The native bush is adapted to occasional fire; plants and animals either survive the fire, or regenerate following it. Many native plant species regenerate best after fire (although along the Avon River, regeneration events are also associated with floods).

Different types of native bush are adapted to different fire regimes. We have no knowledge of the ‘natural’ fire regime that would have occurred in the Avon valley before agricultural development, but it can be inferred from the presence of fire-tender species such as Swamp Sheoak (Casuarina obesa) that fires may not have naturally occurred more frequently than every 15 or 20 years.

However, the strip of bush along the Avon River and its tributaries is no longer in its natural state. The surrounding country has been largely cleared and converted to crop land, pasture and urban development, limiting opportunity for recolonisation of burnt areas by native birds and animals.

Many weeds (especially exotic annual grasses) are thickly established in the bush, while in some places the native herbivores have been displaced by sheep.

Whilst fire is a natural factor in the bush, it can be a damaging agency in degraded bush. In particular, frequent fires enhance further weed development that in turn leads to higher annual fire hazards. Fire is a useful (indeed often essential) agent for bushland regeneration, but if it occurs too frequently, it can eliminate some native species and if it is too intense, it can burn down valuable habitat trees and accelerate erosion along the river banks.

Uncontrolled summer fires are also a threat to human values. Along the Avon River are several towns, minor settlements, farms businesses, bridges, powerlines, railways, tourist sites and historic buildings. These assets need to be protected from bushfires, including fires that may start in the river system.

The AWC has no significant resources at this stage to carry out fire management programs or to fight fires. We are therefore dependent upon the assistance of local Bushfire brigades and neighbours; equally they are dependent upon us to ensure our policies and river management plans are practical as well as visionary.

## Strategies

In order to achieve its objectives, AWC will:

1. Undertake a Wildfire Threat Analysis of the river system. This will be done in conjunction with Local Authorities and experienced Bushfire personnel in each district. The purpose will be to identify all the important values that are potentially threatened by a fire starting in the river system.

2. Develop fire management plans to cover the areas of the river adjacent to identified high value sites and adjacent land as necessary. These plans will deal with issues such as access, firebreaks, fire suppression plans and hazard reduction, and will set out the various responsibilities for decision-making by those involved in doing the work which is prescribed. All plans will be undertaken with full community involvement. Final plans must be submitted to the AWC for consideration, and a recommendation will be made to the Department of Water (DoW) for endorsement if appropriate.

3. Aim to keep fire permanently out of as much of the riverine system as possible, except where fire is used for hazard reduction, regeneration or control of weeds or feral animals under the terms of an approved management plan.

4. Allow the use of controlled fire, or selective herbicides to control annual grass fuels in areas where hazard reduction is approved to protect a high value site. In the case of controlled burning, a prescription must be prepared which specifies season and intensity of fire, the measure to be taken to ensure the fire is made safe, and that mopping up and patrolling is undertaken to protect old trees, hollow logs etc. In the case of herbicide spraying, a prescription must be prepared which specifies the frequency, chemical to be used, the rate and time of application and the measures to be taken to protect non-target species or guard against off-site effects.

5. All controlled burning must be in accordance with the *Bush Fires Act* and meet Local Government requirements, and all prescriptions must be submitted to the AWC for consideration, and a recommendation will be made to the DoW for endorsement if appropriate.

6. Uncontrolled grazing by sheep, cattle, goats, pigs or horses will not be permitted in the river system in areas controlled by DoW. Some limited controlled grazing may be approved during an interim periods in which other hazard reduction measures are being developed. Proposals to graze DoW-controlled land must be submitted to the AWC for consideration, and a recommendation will be made to the DoW for endorsement if appropriate.

7. Owners of riverine vegetation will be encouraged to phase out or limit grazing on their lands in favour of less destructive measures of hazard reduction.

8. New weed invasion will be minimised by minimising all forms of soil disturbance along the river. This especially applies to roads and firebreaks, off-road vehicle use and urban development, none of which may take place along the river without approval of DoW.

9. Permit the mowing or slashing of weeds in some areas close to towns, buildings or other constructions so as to break down a tall grassy fire hazard. Prescriptions covering the proposed work must be submitted to DoW for approval.

10. Encourage neighbours to the river to make their own properties fire-safe, rather than rely on fire hazard reduction along the river. This will be achieved through education campaigns, including detailed discussion with property owners and the involvement of neighbours in the preparation of fire management plans for the river system.

11. AWC will also support measures promoted by Landcare groups to minimise stubble burning on farmlands adjacent to the waterways.

12. Encourage research to be undertaken on the management of fire and on fire ecology along the Avon River. AWC wishes to recover the full suite of native plants and animals that once occurred in the bush in this area, but at the same time we wish to ensure neighbouring assets are protected. AWC will assist scientists from government agencies and universities who are prepared to work on research projects that help to achieve this aim.

13. Monitor all areas burnt. Where good regeneration of desirable species has occurred, areas will be set aside from prescribed burning for a sufficient period to enable the young plants to establish, flower and seed.

14. AWC will strongly support volunteer Fire Brigades located along the river, to ensure they are properly equipped and organised. This support will take the form of collaborative submissions to Local Authorities and the Bush Fires Service, until we are in a position to provide direct financial support.

15. Potential sources of fire in or adjacent to the river system will be identified. Where there are obvious problem sites (eg, smouldering rubbish tips) the site-manager will be approached to fix the problem. If necessary AWC will ask Local Authorities or the Bush Fire Service to enforce the *Bush Fires Act* to eliminate potential sources of fire.

16. Open fires will not be permitted in camp grounds or other recreational areas controlled by DoW along the river during restricted or prohibited burning periods, generally between the months of September and May.

17. AWC will seek endorsement of this Recovery Statement, and all fire management plans developed for the river system from local authorities, neighbours and relevant government agencies (especially the Bush Fire Service).

18. AWC will ensure that all fire management plans and regimes that are developed are consistent with the ACC Natural Resource Management Strategy

## Review

The Recovery Statement will be reviewed annually.

**Alan Cole**
Chairman, Avon Waterways Committee
July 2003

# Publication feedback form

The Department of Water welcomes feedback to help us to improve the quality and effectiveness of our publications. Your assistance in completing this form would be greatly appreciated.

Please consider each question carefully and rate them on a 1 to 5 scale, where 1 is poor and 5 is excellent (please circle the appropriate number).

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