River Action Plan for Gynudup Brook and Tren Creek

2004

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River Action Plan for the Gynudup Brook and Tren Creek

2004

Prepared for the Capel Land Conservation District Committee and the Geographe Catchment Council (GeoCatch).

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by

John McKinney

Funded by the Natural Heritage Trust, Iluka Resources Pty Ltd, the Shire of Capel, and the Department of Environment.

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How to use this river action plan

This River Action Plan (RAP) was prepared for the Capel LCDC, GeoCatch and landholders within the catchments of Gynudup Brook and Tren Creek.

It is divided into 6 sections:

- Chapter 1 provides background information on the River Action Plan, including aims and objectives.
- Chapter 2 provides general information about the study area including soils and landforms, climate, history and heritage.
- Chapter 3 details the methodology used in assessing the condition of the rivers and creating this action plan.
- Chapter 4 outlines general management issues found in the catchments.
- Chapter 5 provides general management recommendations and advice.
- Chapter 6 includes maps showing detailed foreshore condition with specific management advice for each section of the waterways. Also included is a list of priority actions that should be used as the starting point for implementation of this plan.

Acronyms

NHT	Natural Heritage Trust
LCDC	Land Conservation District Committee
DCLM	Department of Conservation and Land Management
GeoCatch	Geographe Catchment Council
WRC	Water and Rivers Commission (now DoE)
DoE	Department of Environment
DoA	Department of Agriculture

Cover photo: Gynudup Brook, Photo John McKinney.

Acknowledgments

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Anita Scott of the Shire of Capel provided information on land tenure and vesting. Kristin Milton and Chris Roach of the Regional Support Branch of the Water and Rivers Commission prepared the maps.

This River Action Plan has drawn extensively on the work by Genevieve Hanran-Smith in the Margaret River, and the Sabina, Abba and Ludlow Action Plans, and Kirrily White and Sarah Comer with the Capel River Action Plan.

The project was funded by the Natural Heritage Trust, Iluka Resources Pty Ltd, the Shire of Capel and the Department of Environment.

Reference details

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Summary

Gynudup Brook and Tren Creek are located just north of Capel in the Capel Land Conservation District in the Geographe catchment. These river systems have been extensively modified as a result of the long history of agriculture in the area, which included extensive clearing and drainage works. In addition, population expansion and other land uses have affected the health of the waterways. Community concern about the health of the waterways, and a desire to protect and improve their health led to the development of this River Action Plan (RAP).

The aim of this RAP is to provide information to landholders, interested community members, the LCDC and GeoCatch regarding the health and current state of Gynudup Brook and Tren Creek and to provide recommendations on how to manage them better.

Assessments were carried out in July, August and September 2003 using the Foreshore Condition Assessment developed by Dr Luke Pen and Margaret Scott for rivers in the south west of Western Australia (Pen & Scott, 1995). Many landholders assisted with the foreshore surveys.

A summary of the foreshore condition ratings and length of fencing of the waterways is presented in Tables 1 and 2.

Key issues identified

The most prominent issues of concern identified during the foreshore assessments and community consultations were:

- Loss of native fringing vegetation and degradation of remaining vegetation;
- Invasion of weeds;
- Erosion and sedimentation of the waterways;
- Water quality issues, including nutrient enrichment and altered hydrological flows; and
- Need for assistance if landholders are to protect and enhance the foreshore by fencing or revegetating.

Summary of general recommendations

In response to these issues, general recommendations to improve the health of Gynudup Brook and Tren Creek are as follows:

- Fence of all waterways to prevent stock damage from grazing and trampling;
- Protect remnant vegetation in the catchment, especially riparian, through reduced stock access and improved weed management;
- Increase the amount and diversity of riparian vegetation, by reducing stock access to allow for natural regeneration and by revegetation and rehabilitation programs;
- Better control of weeds and feral animals such as rabbits and foxes;
- Establish erosion control methods on waterways by seeking advice from the Department of Environment; and
- Reduce sediment and nutrient export from agricultural areas by planting buffer strips and implementing accepted best management farming practices.

It was noted by many landholders that funding and the time required for revegetation and restoration works are limiting factors. Some funding assistance to implement management recommendations is available through the Capel LCDC. For more information, please contact your Landcare Officer. Contact details for relevant persons, agencies and community organisations are listed in Appendix 4.

A set of prioritised actions is listed at the end of Chapter 6. They will provide a useful starting point for the implementation of this RAP. They include a balanced mix of short and long-term activities and practical on-ground work combined with community education and strategic planning activities.

Table 1: Summary of foreshore condition rating of Gynudup Brook and Tren Creek

Condition	Gynudup Brook		Tren Creek	
	Total Length	Total %	Total Length	Total %
A (pristine)	0 km	0%	0 km	0%
B (weedy)	13.7 km	13%	0.3 km	1.1%
C (erosion prone/eroding)	25.9 km	24.6%	3.9 km	15.9%
D (ditch)	66.1 km	62.5%	20.3 km	82.7%

Table 2: Length of fenced areas on Gynudup Brook and Tren Creek

	Gynudup Brook		Tren Creek	
	Length Fenced	% of Length	Length Fenced	% of Length
North/Right Bank (facing downstream)	19.4 km	16.0%	5.4 km	22.4%
South/Left Bank (facing downstream)	15.2 km	12.5%	3.4 km	13.9%
Total fenced	34.6 km	14.3%	8.8 km	17.9%

1. Introduction

Background

In recognition of the need to address the poor state of the rivers in the Geographe catchment, and following consultation with the relevant Land Conservation District Committees, GeoCatch submitted a Natural Heritage Trust (NHT) application for the development of a number River Action Plans in 1997. The project was funded through the National Rivercare component of NHT, which operates under the goal:

> *To ensure progress towards the sustainable management, rehabilitation and conservation of rivers and to improve the health of these river systems.*

That project led to the successful development and ongoing implementation of River Action Plans for the Capel, Vasse and Carbunup Rivers and Yallingup Brook.

This project continues the series, and reflects the goal of completing a RAP for all waterways in the Geographe catchment. It also reflects community concern about the health of Gynudup Brook and Tren Creek.

The partners in developing and implementing this project are the Capel LCDC and GeoCatch, with funding from the National Heritage Trust, Iluka Resources Pty Ltd, the Shire of Capel and the Department of Environment.

Study aims

The primary aims of this River Action Plan are:

- To produce a detailed description of the current state of Gynudup Brook and Tren Creek and a prioritised plan of action to guide works to improve the health of these waterways.
- To provide a benchmark against which the local community's future work to protect and rehabilitate the waterways can be gauged.
- To provide a tool to guide the use of the funding and assistance available for fencing, weed and erosion control, and the planting and rehabilitation of native vegetation.
- To provide a sound technical basis for future funding or project submissions.
- To undertake this process in a way that ensures constructive involvement by the local community in the assessment and decision making process.

2. Study area

Gynudup Brook and Tren Creek were surveyed from their headwaters in the State Forest and near Gavins Rd respectively, to where the Tren meets the Gynudup and then along Gynudup Brook to where it meets the Capel River. Also studied were a number of agricultural drains that have been constructed and now either flow into, or direct flow away from, Gynudup Brook or Tren Creek.

The location of the study area is shown in Figure 1. Background information about the study area is discussed below.

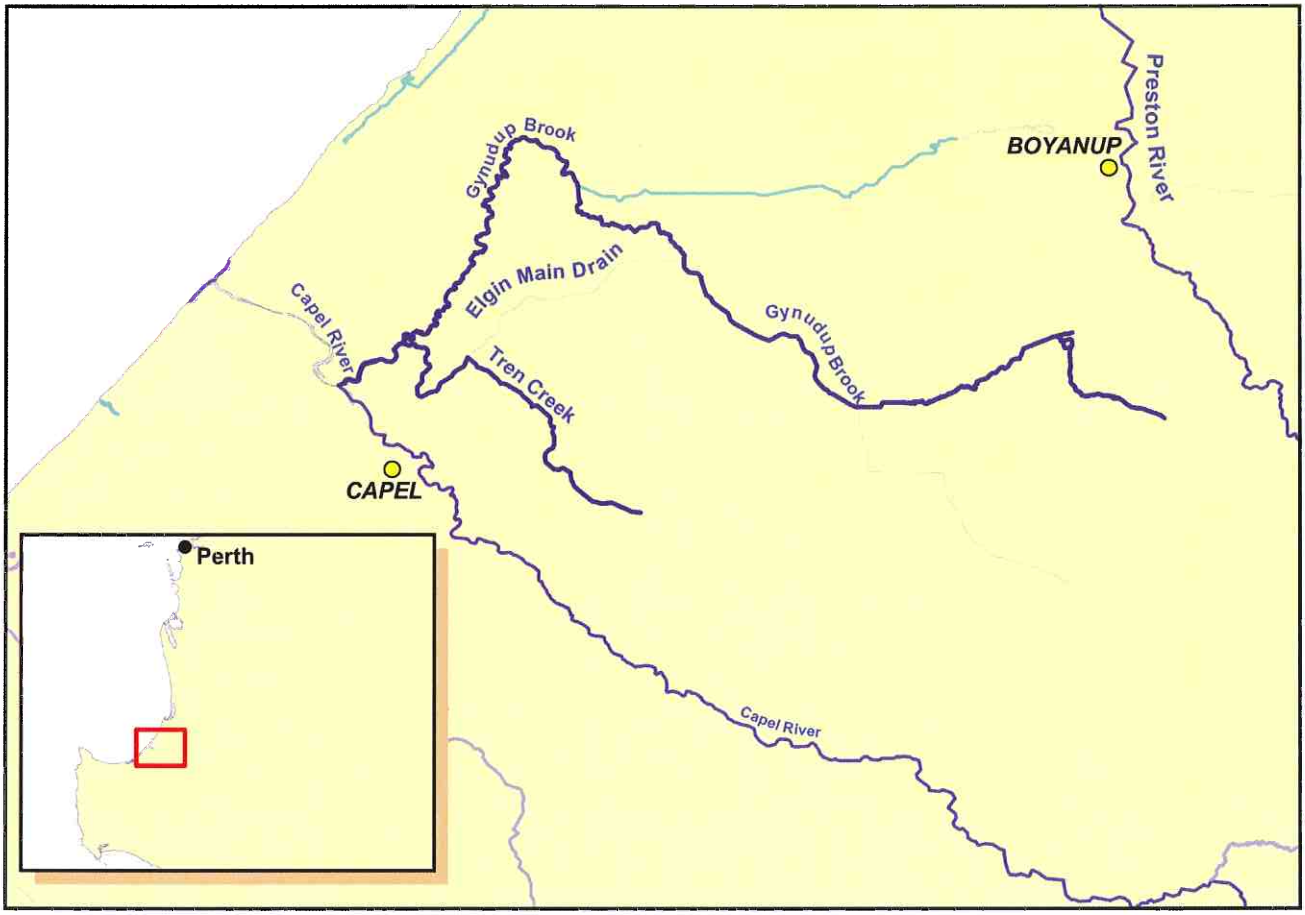


Figure 1: Study area

Climate

The area has a Mediterranean climate with hot, dry summers and mild, wet winters. The average annual rainfall is approximately 850 mm at Capel.

Anecdotal evidence from landholders supports data that shows a 10-25 percent decline in annual rainfall in the south west of Western Australia from the long-term climate mean (Government of Western Australia, 2003; Hennessy, 2002). This is due to a reduction in the mean number of raindays, and the mean number of heavy raindays in winter. The reduction in total annual rainfall is shown in Figure 2 below.

Landform and soils

Gynudup Brook and Tren Creek occur in three distinct landform units and four land systems . Gynudup Brook starts in the Whicher Scarp system of the Blackwood Plateau, before flowing briefly across the Forrestfield land system of the Darling Scarp, and then onto the Pinjarra Plains and Bassendean Sands of the Swan Coastal Plain (Barnesby & Proulx-Nixon, 1994; Tille & Lantzke, 1990). Brief descriptions of the land systems and soil types are listed below.

Blackwood Plateau Unit

Whicher Scarp

A low scarp on the northern edge of the Blackwood Plateau. The main soils include sandy gravel, loamy gravel, pale deep sands and non-saline wet soils.

Darling Scarp Unit

Forrestfield

This land system is the foothills of the Darling Scarp, and comprises fossil shoreline bench sediments, Holocene colluvium and narrow alluvial bands. The two main soil types found in the study area are:

- Very low relief footslopes with rapidly drained deep bleached grey sands and occasionally deep yellow brown sands. There is a minor occurrence of gravel in this soil type.
- Incised stream channels on low relief footslopes with moderately drained bleached and pale yellow brown gravely sands.

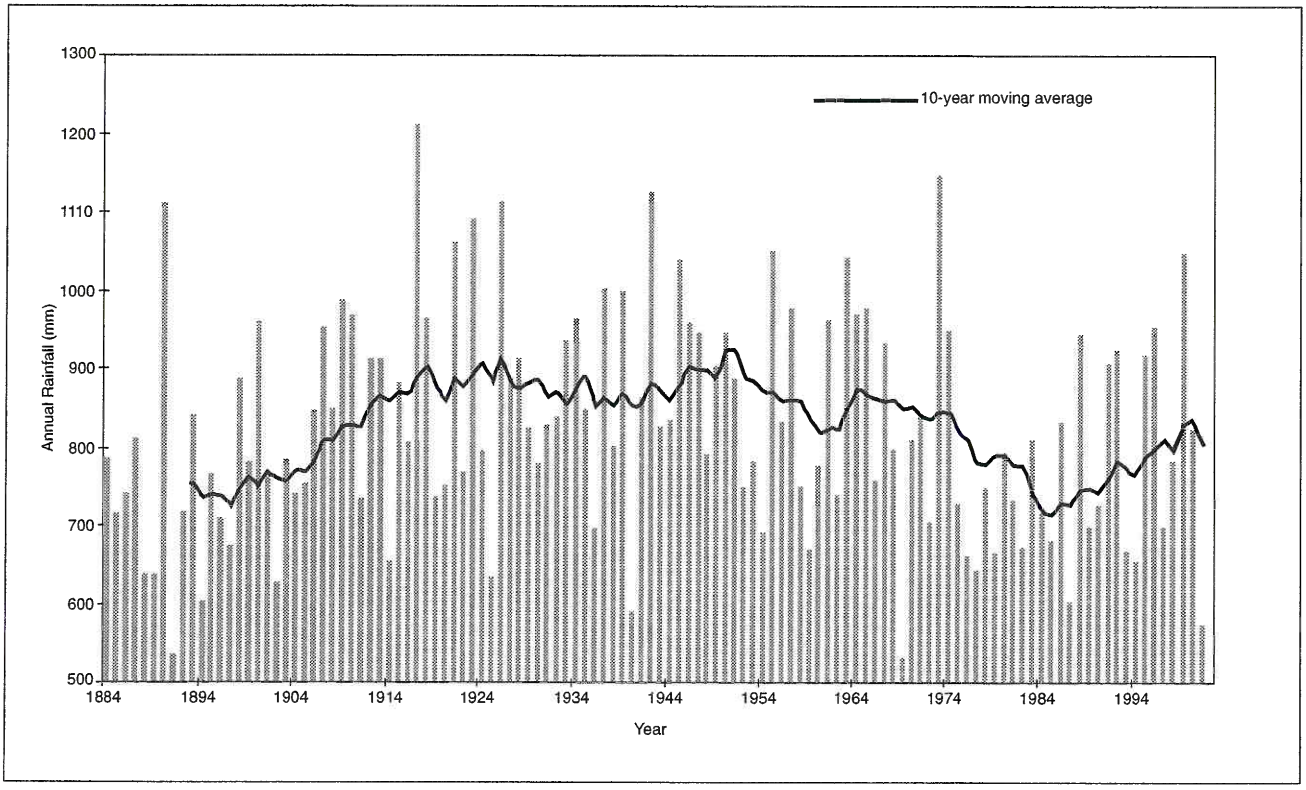


Figure 2: Annual total rainfall for south west Western Australia. Source Hennessy (2002).

Swan Coastal Plain Unit

Pinjarra Plains

This is the main land system found in the study area, and is a broad low relief plain west of the foothills of the scarp, comprising mainly Pleistocene fluvial sediments with some Holocene alluvium that is associated with major current drainage systems. The soils are generally naturally poorly draining and many swamps occur. The main soil types found in the study area are:

- Flat to very gently undulating plains with acidic mottled yellow duplex soils that are imperfectly drained shallow or moderately shallow pale sands to sandy loams over clay.
- Flat to very gently undulating plains with deep moderately to imperfectly drained gradational or duplex soils, with loam to clay loam surface horizons and subsoils going alkaline.
- Shallowly incised stream channels of minor creeks and rivers with deep acidic mottled yellow duplex soils.

Bassendean Sands

Isolated patches of this land system occur at the northern and southern edges of the study area and comprise very low relief, leached, grey siliceous Pleistocene sand dunes, intervening sandy and clayey swamps and gently undulating plains. Where this land system occurs, it overlies the Pinjarra Plain. The three main soil types of this system that were found are:

- Extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than two metres; Banksia dominant.
- As above, but more intensely coloured yellow B horizon occurring within one metre of the surface; Marri and Jarrah dominant.
- Sandplain and broad extremely low rises with imperfectly drained deep or very deep grey siliceous sands.

There are a number of mineral sand (mainly ilmenite) deposits found in the study area. They occur in the Bassendean Sands and in a small band of the Spearwood System near Bussell Highway in the west (Baxter, 1977). It should also be noted that acid sulfate soils are found in the area. For more information on acid sulphate soils contact your Landcare Officer, or the Department of Environment.

The Department of Agriculture is currently updating its soil and landform database. A CD containing more detailed information is now available from the Department and local libraries.

Flora and fauna

The study area lies within the Geographe catchment, and vegetation in this catchment is very diverse, varying according to landform, geology and soils. According to the Remnant Vegetation Strategy for the Geographe Bay Catchment (Connell et al., 2000a), there are 46 different vegetation communities in the area, and it is well known for its floristic diversity. In addition, there are Declared Rare and Priority Flora and Threatened Ecological Communities in the Capel-Boyanup area (A Webb, pers. comm., 2003).

Major vegetation types and species lists for the Geographe Bay catchment are listed in Weaving (1998). The vegetation types found during the field surveys include a low open forest of Flooded Gum and Paperbark (primarily *Melaleuca rhaphiophylla* with some *M. preissiana*), a Jarrah and Marri open forest with Banksia and Mountain Marri, an open woodland of Marri and Jarrah, and a Banksia woodland with Jarrah and Marri.

Apart from the State Forest, the majority of the vegetation in the study has been cleared and what remains is degraded and under threat. Complete species lists and locations for all flora surveyed during the project can be found in Appendix 1. This can be used to develop a list of species local to each area that would be suitable for revegetation projects and home gardens.

Riparian (creekline) vegetation provides a rich habitat for a variety of native fauna. Large numbers of waterbirds, including a variety of ducks, ibises, spoonbills, herons, egrets, swamp and moor hens,

grebes, swans and cormorants were observed. Also found, or noted during community consultations, were marron (*Cherax tenuimanus*), freshwater turtles (*Chelodina oblonga*), freshwater mussels (*Westralunio carteri*) and native fish species, possibly western pygmy perch (*Edelia vittata*) or western minnows (*Galaxias occidentalis*). The occurrence of these native fish species could not be confirmed, however according to Water and Rivers Commission (1996), it is likely that they were once found, or still are found in the area. The only fish positively identified in the study was the introduced mosquito fish (*Gambusia holbrooki*), which was found in a number of locations. A number of landholders stated that there are large numbers of introduced carp in the waterways. It may be worthwhile therefore for the LCDC, possibly in conjunction with Ribbons of Blue, to conduct a fish survey to ascertain what local and exotic species are found in the catchment.

In addition, six frog species were positively identified, either through their calls or by sight. They were the Quacking Frog (*Crinia georgiana*), Clicking Froglet (*C. glauerti*), Squelching Froglet (*C. insignifera*), Banjo Frog (*Limnodynastes dorsalis*), Motorbike Frog (*Litoria moorei*) and the Whooping Frog (*Heleioporus inornatus*). The Capel Primary School, with support from Ribbons of Blue and the LCDC, could construct a fish and frog pond, with local species and vegetated with local plants, to facilitate learning and understanding about the life and health of local waterways.

The river systems and the wetlands

The headwaters of Gynudup Brook begin in State Forest 27 before travelling in a north westerly direction across a series of very gently undulating valleys and flats of mainly agricultural land. The headwaters of Tren Creek begin as a series of low-lying depressions in pasture land, and begin to take shape as a series of swale drains running through pasture and Bluegum plantations.

There is a major diversion drain (Elgin Main Drain), constructed in 1958, that diverts all flow of Gynudup Brook upstream of Elgin Rd. This travels in a south westerly direction, where it enters Tren Creek. This section is known both as Tren Creek and Elgin Drain. This then enters Gynudup Brook just west of Bussell Highway. Gynudup Brook then enters the Capel River and flows via the Stirling Wetlands to the Indian Ocean. There is a floodgate at the mouth of the Capel River that impacts on upstream water quality in the Capel River, Gynudup Brook and Tren Creek. This is discussed further in Chapter 4.

Like many of the waterways on the Swan Coastal Plain, Gynudup Brook and Tren Creek have been extensively modified as a result of agriculture in the area. Large scale clearing in the catchment and the creation of a series of drainage networks have resulted in natural waterways being diverted, straightened, widened, dug out and de-snagged, filled in and bypassed. This has fundamentally altered the local hydrological regime in the area. As a result, there have been increased water flows which combined with loss of fringing native vegetation, has led to and exacerbated erosion. There have also been reduced flows in sections of Gynudup Brook due to the diversion of the main channel through the Elgin Main Drain. This has created its own suite of management issues.

In addition to natural flows, there are a number of licensed and unlicensed discharges into Gynudup Brook and Tren Creek from mining, horticultural and agricultural operations. These discharges influence the timing and size of flows across the year.

Heritage

Indigenous heritage

Prior to European contact the Aborigines of the South West Region formed a distinctive socio-cultural group collectively known as Nyungar (O'Connor *et al.* 1995). The group of Nyungar people that occupied the coastal area of the Geographe Bay catchment were known as the Wardandi people, 'the people that lived by the ocean and followed the forest paths' ('Wardan' meaning 'ocean') (Collard, 1994).

It has been noted that the region's waterways were the main focus of Aboriginal traditional life especially from the viewpoint of food and drink, being living areas and highways along which seasonal migrations occurred (O'Connor *et al.* 1995). It is known that the land as a whole, but especially waterways, are spiritually

important to Aboriginal people, because of the 'Dreaming' (Berndt & Berndt, 1996). There is evidence of Indigenous occupation in the south west of Western Australia for at least 47,000 years (Dortch, 2000).

The seasonal movement of Aboriginal groups related to the exploitation of various resources available in the different environmental situations. It has been noted by early settlers such as Captain Stirling and others, that various water bodies on the coastal plain such as creeks, rivers and wetlands were an important source of food in summer, providing plentiful fish, waterbirds, turtles and frogs, as well as vegetable foods. In winter, Aboriginal groups generally moved inland, as there were abundant kangaroo, emu and roots and tubers, and the seasonal inundation of the coastal plain would have made travelling and camping in and through these areas difficult and unpleasant. It is likely that migration patterns also reflected social, cultural, and economic factors (O'Connor et al. 1995).

According to local Aboriginal Elder for the area, Vilma Webb, the name of Gynudup Brook itself highlights the importance of this waterway to Aboriginal people. It means good campground near water (V. Webb, pers. comm., 2003).

Three sites have been registered with the Department of Indigenous Affairs within the catchment of Gynudup Brook and Tren Creek. They are two artefact sites and a mythological site. Physical evidence in the form of spear tips/knife blades was found at one site during a visit with local Elders. In addition to the numerous other sites registered within the Capel River catchment and surrounding area, it is likely there are sites within the Gynudup Brook and Tren Creek catchments that have not been registered. In fact, on a visit to the area by the Elders, they felt that another site, a campground, was found, although a quick search of the area found no physical evidence. A more complete search, with the permission of relevant landholders to enter private land, may produce physical evidence such as stone flakes or spear tips. It is recommended that further anthropological and archaeological studies be completed in the region.

It is essential that before any on-ground projects are implemented there is full and complete consultation and involvement of the local Indigenous community.

European heritage

The area in question has a long history of European occupation and settlement, with settlement in the Geographe region initiated by Captain Stirling in 1827 and followed by Bussell in 1833. In the Capel area the first settlers arrived in 1843, and the local community was boosted by the construction of a water driven flour mill in 1851 (GeoCatch, 1999, citing Horwitz & Wardell-Johnson, 1996). Government programs such as the construction of the railway between Bunbury, Boyanup, Capel and Busselton between 1889 and 1918, and post-war resettlement schemes also served to boost local populations.

Following the extensive drainage works in the Busselton area at the turn of the 20th century, a series of drainage programs were initiated in the Capel/Boyanup area to increase the agricultural productivity of land, as much of it was seasonally inundated and unproductive. This drainage network, including the Elgin Main Drain, has significantly altered the local hydrological regime, and is a significant factor in many of the management issues. This is discussed in Chapter 5.

For more information on European heritage in the Capel area, see *Just A Horse Ride Away* by Chase and Krantz (1995).

Population growth

As for the south west as a whole, parts of the Shire of Capel are under heavy pressure from population growth. For the last ten years, with the exception of 1996, the population growth of the Shire of Capel has been well above the growth rate of regional Western Australia as a whole. On average, population growth in the Shire of Capel has been 2.7 percent, compared to the regional WA average of 1.3 percent (Department of Local Government and Regional Development, 2003). This population growth increases the pressure on the environment in the region.

Land tenure

The majority of the lots adjoining both Gynudup Brook and Tren Creek are privately owned, and corresponding lot and location numbers are shown on the maps in Chapter 6. The upper reaches of Gynudup Brook begin in State Forest 27, and there are sections of both Gynudup Brook and Tren Creek that contain both vested and unvested Crown reserves. These reserves are listed in Table 3 below.

Summary

The issues that are present in the catchments are very complex. There are always limited resources available to landholders, community groups and government agencies. Therefore, we used a methodology that prioritises management issues and associated recommendations. The Pen-Scott method of foreshore assessment was used. This, plus extensive community consultation allows us to understand the issues that face the local community and to develop an action plan to address them. The next section discusses this methodology in detail.

Table 3: Reserves on Gynudup Brook and Tren Creek.

Waterway	Lot Number	Reserve Number	Map Number	Vesting	Purpose
Gynudup Brook	5084	Crown Reserve 30859	1	Water Corp	Drainage
Gynudup Brook	5432	Crown Reserve 38581	1	Unvested	Drainage
Gynudup Brook	4888	Crown Reserve 46592	2	Unvested	Government Requirements
Gynudup Brook	5443	Crown Reserve 38581	2	Unvested	Drainage
Gynudup Brook	406	Crown Reserve 26745	3 and 8	Water Corp	Drainage
Gynudup Brook	420	Crown Reserve 37372	5	Water Corp	Drainage
Gynudup Brook	471	Crown Reserve 46952	9	Water Corp	Drainage
Gynudup Brook	5138	Crown Reserve 32103	11	Unvested	Drainage
Gynudup Brook	200	State Forest 27	14, 15, 19, & 20	Unvested	State Forest
Gynudup Brook	283	Crown Reserve 2314	16	Shire of Capel	Archery Club
Gynudup Brook	213	State Forest 27	18	Unvested	State Forest
Gynudup Brook	212	State Forest 27	19	Unvested	State Forest
Tren Creek	5951	Crown Reserve 30859	3	Water Corp	Drainage
Tren Creek	5952	Crown Reserve 30859	3	Water Corp	Drainage

3. Study methodology

Community involvement

Community involvement is an integral component of River Action Plans. As such, every effort was taken to involve the community at each stage of the process from initial assessments to developing management recommendations. Participative decision making was used throughout the study.

Most of the assessments were conducted with the landholders, and they were able to provide invaluable historical and anecdotal information on Gynudup Brook and Tren Creek. Importantly, they provided their views, explained what their concerns were, and why and how they felt the waterways should be managed. Others provided valuable information and assistance. All of the recommendations are either standard good practice, such as addressing erosion, or have been discussed with landholders or other stakeholders, and major on site activities that we have recommended were developed with the landholders involved and directly affected.

Other consultation processes included numerous individual phone calls, articles and advertisements in local and regional newspapers, and information available at farmers markets and local stores to encourage the local community to become involved. Approximately halfway through the survey, a community meeting was held to present initial findings and to seek feedback about the project and management recommendations from the community.

Feedback from these formal and informal discussions with stakeholders has been incorporated into this action plan. The community consultation process was useful to report the results of the assessments and to gain feedback on the approach, the validity of the assessments for the local community and landholders, and the relevance and practicality of the proposed priorities for action.

River foreshore condition assessment

The Pen-Scott method of riparian zone assessment was used. This system provides a graded description of the river foreshore from pristine (A grade) through to degraded (D grade). A summary of the grades of the Pen-Scott system follows (Pen & Scott, 1995; Water and Rivers Commission, 1999a). These are illustrated in Figure 3 and photos on the following pages. This method allows comparisons of waterway health across the south west of Western Australia, and can be used to prioritise actions.

A grade foreshore

A1: Pristine

The river embankments and/or channel are entirely vegetated with native species and there is no evidence of human presence or livestock damage. This category, if it exists at all, would be found only in the middle of large conservation reserves where the impact of human activities has been negligible.

A2: Near pristine

Native vegetation dominates but introduced weeds are occasionally present in the understorey, though not to the extent that they displace native species. Otherwise there is no human impact. A river valley in this condition is about as good as can be found today.

A3: Slightly disturbed

Here there are areas of localised human disturbance where the soil may be exposed and weed density is relatively heavy, such as along walking or vehicle tracks. Otherwise, native plants dominate and would quickly regenerate in disturbed areas should human activity decline.

B grade foreshore

B1: Degraded - weed infested

In this stage, weeds have become a significant component of the understorey vegetation. Although native species remain dominant, a few have probably been replaced or are being replaced by weeds.

B2: Degraded - heavily weed infested

In the understorey, weeds are about as abundant as native species. The regeneration of some tree and large shrub species may have declined.

B3: Degraded - weed dominated

Weeds dominate the understorey, but many native species remain. Some tree and large shrub species may have declined or have disappeared.

C grade foreshore

C1: Erosion prone

hile trees remain, possibly with some large shrubs or Grass Trees, the understorey consists entirely of weeds, mainly annual grasses. Most of the trees will be of only a few resilient or long-lived species and their regeneration will be almost negligible. In this state, where short-lived weeds support the soil, a small increase in physical disturbance will expose the soil and render the river valley vulnerable to serious erosion.

C2: Soil exposed

Here, the annual grasses and weeds have been removed through heavy livestock damage and grazing, or other impacts such as a result of recreational activities. Low level soil erosion has begun, by the action of either wind or water.

C3: Eroded

Soil is being washed away from between tree roots, trees are being undermined and unsupported embankments are subsiding into the river valley.

D grade foreshore

D1: Ditch - eroding

Fringing vegetation no longer acts to control erosion. Some trees and shrubs remain and act to retard erosion in certain spots, but all are doomed to be undermined eventually.

D2: Ditch - freely eroding

No significant fringing vegetation remains, and erosion is completely out of control. Undermined and subsided embankments are common, as are large sediment plumes along the river channel.

D3: Drain - weed dominated

The highly eroded river valley may have been fenced off enabling colonisation by perennial weeds. The river has become a simple drain, similar if not identical to the typical major urban drain.

It should be noted that, in this catchment, a foreshore that is assessed to be D3 may require less management than a D1/D2 foreshore. This is because the weeds, predominantly Kikuyu, may serve to hold the bank together and there is consequently less erosion than with a bare or denuded bank. This assumes however, that the D3 section of foreshore is so degraded that it would be impossible, or cost prohibitive, to restore it back to a natural system. This is discussed more fully in Chapter 5.

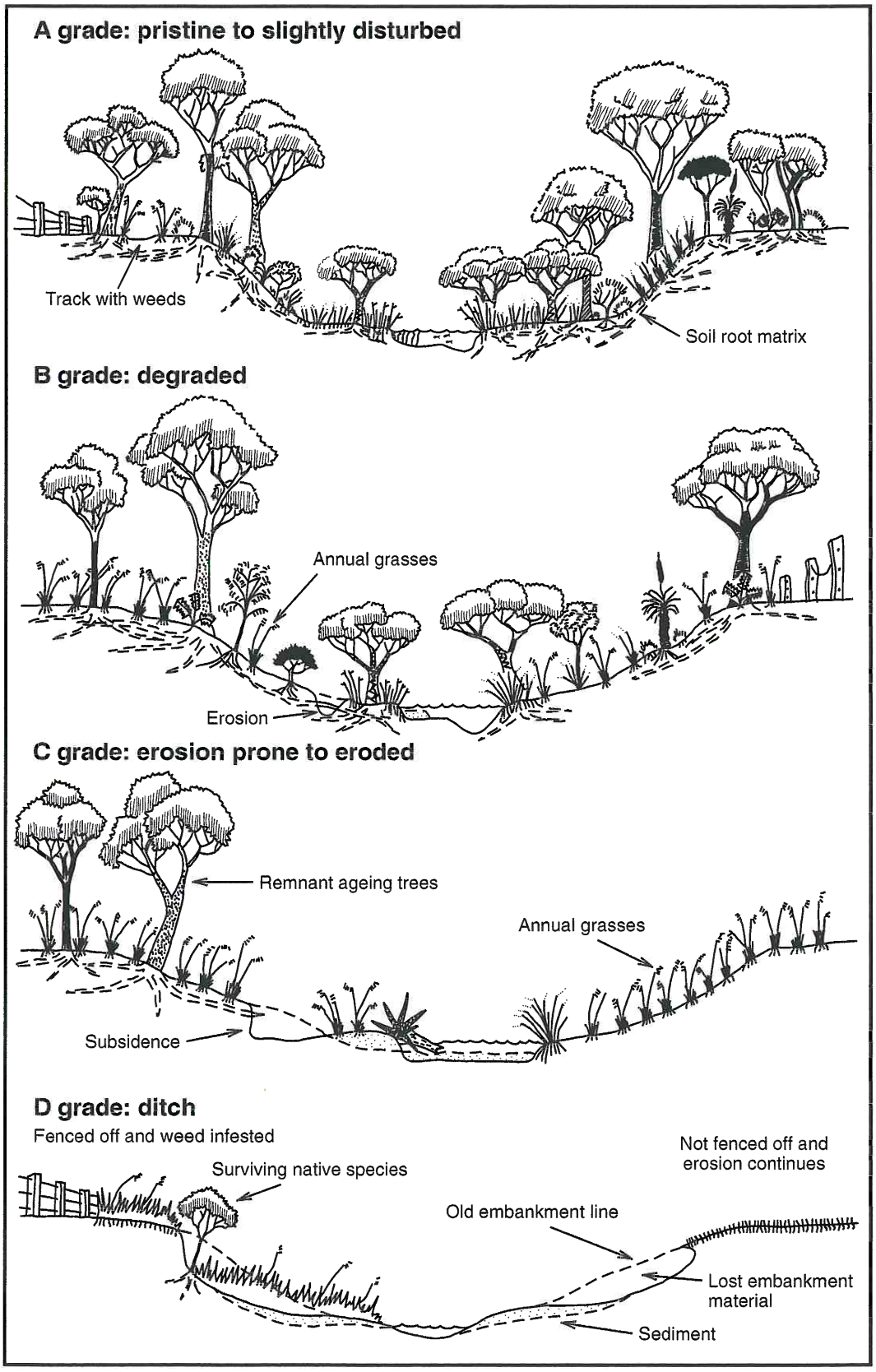


Figure 3: The four grades of river foreshore condition - (A) pristine to ditch (D)

A Grade foreshore of the very upper reaches of Gynudup Brook in the State Forest. Although there is minimal flow in this section, the fringing vegetation provides habitat and shades the waterway.

B Grade foreshore on Gynudup Brook near Capel River. Some understorey (mainly rushes and sedges) remains and helps to retard erosion, but there is significant weed growth.

B Grade foreshore on Gynudup Brook. Note the very thin strip of native vegetation. Such a narrow strip is very sensitive to disturbance and degradation. A wider strip would be more resilient and trap sediments and nutrients entering the brook. The opposite bank is C1/C2.

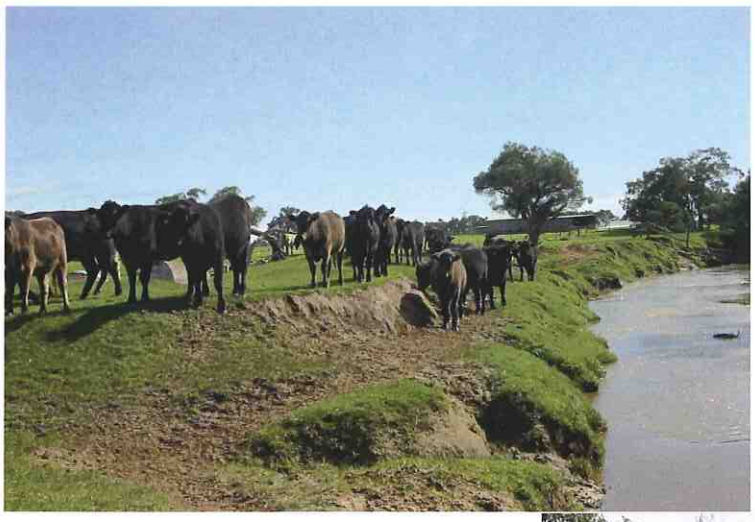
C1 Grade foreshore on Gynudup Brook. Note mature trees only, no exposed soil, and complete invasion by weeds, particularly grasses such as Kikuyu. This foreshore is very vulnerable to disturbance such as stock grazing and trampling. The grasses serve to hold the bank together slightly, but not as effectively as a variety of native species.

C2 Grade foreshore on Gynudup Brook. Some erosion and sedimentation (point bar formation) is occurring, especially on bends. This is due to a lack of native understorey vegetation that serves to dissipate flows and hold the bank together.

C3 Grade foreshore. Tree roots are barely holding bank in place, with undercutting and subsidence apparent. Only mature trees remain, with no regeneration of local species, as a result of stock access and weeds. These trees are all doomed to be undermined eventually unless supported by revegetation projects using a variety of local species.

D1 Grade foreshore on Tren Creek/Elgin Drain. Very little fringing vegetation apart from isolated mature trees and grassy weeds. Banks are subsiding with a large amount of sediment being transported downstream.

D2 Grade foreshore. No fringing vegetation remains and banks are freely eroding, resulting in massive sediment transport downstream, loss of productive land and serious downstream water quality issues.



D2 Grade foreshore, showing a major cause of problems in the catchment – unrestricted stock access.

D3 grade foreshore. This drain has no remaining fringing vegetation, and is heavily infested with exotic species. The banks are stable however, and erosion is not a significant issue in this part. It is important to ensure invasive weeds are well managed to minimise potential problems downstream.

D3 grade foreshore. This drain is approximately 1 metre wide, with very low flows. Due to the low flows, the grasses and clovers are able to hold the bank together and there is little erosion occurring,

4. Management issues

There are a number of management issues in the Gynudup Brook and Tren Creek catchments. They vary according to landform and soils, past and current land use and management practices, and the degree of modification due to drainage. These interrelated issues are summarised below.

Water quality and drainage

A number of drainage, water use and water quality issues are of significant concern in the catchment.

Drainage

The whole of the Gynudup Brook and Tren Creek catchment has been heavily modified by the creation of drainage networks. The area is part of the Busselton Drainage District. The Elgin Main Drain was approved in 1958, and construction commenced soon after. Large parts of the natural waterways in the catchment have been straightened, de-snagged, dugout, filled in, or bypassed.

Most of these drainage lines have no fringing vegetation, and often have levee banks created with the excavated spoil. There are a number of issues associated with this drainage network. They include increased water flows due to more water flowing more rapidly off paddocks, which can create and exacerbate erosion. Other issues include loss of fringing vegetation, and in one stretch of Gynudup Brook, significantly reduced water flows which impacts upon downstream users.

Water extraction and allocation

A number of landholders within the catchments of Gynudup Brook and Tren Creek currently extract water from these systems. Under the *Rights in Water and Irrigation Act 1914* 'riparian rights' allow landholders to take water for specific non-commercial purposes such as domestic use, or non-intensive stock watering (Water and Rivers Commission, 2001). Riparian rights only occur where there is a stream flowing through a property or the property abuts the watercourse and there is no publicly reserved land between the watercourse and the private property. Extracting water for commercial purposes or in excess of riparian rights may require a licence from the Department of Environment (previously the Water and Rivers Commission). Riparian rights only give access to what water is available, and are not a guarantee of supply.

In addition, where there is a Crown reserve between the private property and the watercourse, the relevant authority must give consent for the landholder to access the watercourse or place equipment on Crown land. Removal of this consent is increasingly being considered as a management tool as water continues to be used unsustainably.

The whole of the Capel River catchment, including Gynudup Brook and Tren Creek, is 'proclaimed' under the *Rights in Water and Irrigation Act 1914*. As such, licensing can be used as a tool to manage surface water extraction (in excess of riparian rights). Through licensing, consideration is given to the ecological water requirements of a system, the economic and social values of a system are also considered in the licensing process.

At the time of the foreshore assessments, little was known about the level of water extraction in the Capel River system. To address this, the Department of Environment has recently commenced a survey to determine water usage information in the catchment. This information will be used to develop management strategies and facilitate the development of a Water Allocation Plan for this catchment.

For more information on water extraction, allocation and licensing, contact the Allocation Branch of the DoE in Bunbury.

Nutrients

There is a great deal of community concern about nutrient enrichment of Gynudup Brook and Tren Creek. Nutrient enrichment can cause algal blooms. This concern was apparent during the foreshore assessments and community consultations. There are a number of dairies, intensive horticulture, viticulture, other agricultural and mining operations in the catchment. Although there are isolated algal blooms in the lower Gynudup Brook (Water and Rivers Commission, 2003), the limited water quality data does not show highly elevated nutrient levels.

The LCDC should, as a priority, expand its current water quality testing regime to include nutrient, dissolved oxygen and turbidity levels in Gynudup Brook and Tren Creek. The Shire of Capel has a Palin test kit that is available for the LCDC to utilise, and Ribbons of Blue will support the LCDC with training and supply of necessary reagents.

Salinity

As part of the Capel LCDC Saltwatch program, total dissolved salt levels have been monitored at one site on Gynudup Brook for approximately 18 months, and more recently at one site on Tren Creek. Results found so far generally indicate brackish water with levels usually between 800 and 2000 mg/L. Further monitoring is required to ensure levels are maintained or decreased due to improved catchment management.

Mallokup Bridge floodgates

There is community concern regarding the management of the floodgates near Mallokup Bridge at the mouth of the Capel River. After the mouth of the Capel River was modified to discharge directly into the Indian Ocean in 1864 and expanded in 1874, a floodgate was installed in 1904 to stop saltwater intrusion into the Capel River (Department of Environment, in preparation).

On 15 May 2003, a major storm event coincided with high tides, forcing salt water over the floodgates and upstream into the Capel River and Gynudup Brook. In additional to potential ecosystem stress, this adversely affected a number of people who live on Gynudup Brook and use the water either for domestic or stock use.

Representatives from the Water Corporation, Department of Environment, the Shire of Capel, community groups, and local landholders are currently meeting to determine best management for these structures. The Water Corporation has committed to replacing the weir and dropgates over the 2003-2005 seasons.

Erosion and siltation

While some level of erosion and deposition is natural within any waterway, the acceleration of these processes can cause management problems. The massive changes to the local hydrological regime, due to the extensive drainage network, combined with disturbance from stock and clearing of fringing vegetation within the catchment has led to serious erosion problems on Gynudup Brook and Tren Creek.

Banks sometimes naturally erode on bends, however when vegetation is cleared they can become unstable causing extensive erosion along the floodway and the subsequent build-up of sediment that is washed downstream (Water and Rivers Commission, 1999b). The altered hydrological regime resulting in greater flow volume and rates compounds the erosion problems caused by the loss of native vegetation and stock damage.

Issues associated with erosion problems include:

- loss of valuable soil;
- loss of fences as the river course deviates;
- poor water quality resulting from increased turbidity and nutrients;
- increased flood potential due to the silting up of the channel;
- filling of summer pools;
- increased channel width and loss of agricultural land;
- reduced visual amenity and recreational sites associated with the waterways; and
- further loss of native riparian vegetation as severe erosion problems cause subsidence.

Stock access

The majority of Tren Creek and Gynudup Brook is unfenced, allowing stock access to riparian vegetation and river channels. There are a number of problems that can arise as a result of unrestricted stock access. They include:

- loss of native fringing vegetation;
- weed invasion;
- compacted soils;

- erosion; and
- poor water quality.

There are a number of reasons why large areas of the waterways are currently unfenced. During the surveys and community consultation, the cost and time involved in fencing was raised repeatedly as a major obstruction. Similarly, stock access for watering and the need to cross Gynudup Brook and Tren Creek were raised. In addition, increased weed and feral animal invasion was highlighted as a common result of fencing of remnant vegetation or waterways. There is also the potential for increased fire risk if weeds are unmanaged. It is very important to note that just excluding stock by fencing is not enough. Active management in terms of weed and feral animal control, and being mindful of erosion problems due to channel blockages, are essential for the protection and enhancement of riparian vegetation.

Loss of native fringing vegetation

Healthy native vegetation remains only along the uppermost reaches of Gynudup Brook. Elsewhere, in parts of the catchment, there is an overstorey of trees with the native understorey degraded or highly degraded through clearing, grazing, erosion and competition with weeds. The majority of Gynudup Brook and Tren Creek foreshores have little or no native vegetation.

Native riparian vegetation has many values as discussed below.

Erosion control

The roots of trees and large shrubs anchor the river embankments in place and prevent them from slumping and subsiding into the channel. The finer roots of shrubs, sedges and rushes hold the banks together preventing soil from being washed away, and protecting trees and shrubs from being undermined.

Dissipating flow

Riparian vegetation increases the roughness of the riverbanks, which serves to dissipate the energy of running water thereby reducing the erosive capacity of the flow. The type of vegetation present determines the extent to which water velocity is decreased. Widely spaced trees are not as effective in reducing velocity as rushes and sedges.

Sediment and nutrient retention

Riparian vegetation slows overland movement of water resulting in sediments and nutrients being deposited on land prior to reaching the river channel. This effect is known as buffering. Grasses, rushes, sedges and shrubs are most effective in achieving this buffering effect. Many species of rushes and sedges can strip nutrients from soil and water, storing significant amounts in stems and rhizomes. They also support bacterial and invertebrate communities that help to break down nutrients and other pollutants. The wider the buffer zone, the more effective it is at retaining nutrients and sediment.

Ecological values

Native fringing vegetation provides a range of habitats for many species of flora and fauna, particularly species that are restricted to moist or aquatic environments. Aquatic plants and animals rely on the leaf litter, insects and organic debris provided by riparian vegetation. Branches and fallen trees provide habitat for aquatic fauna. The shade provided by fringing vegetation is important in keeping water temperature low, as many native aquatic plants and animals cannot tolerate a high water temperature. A lower temperature also reduces the risk of algal blooms. Vegetation along stream systems also provides a corridor along which fauna can move and may link areas of remnant vegetation. Many species also help to oxygenate the water by 'leaking' excess oxygen from their roots (Water and Rivers Commission, 2000). When densely planted, many rushes and sedges can out-compete weeds such as Kikuyu, *Juncus microcephalus* and *Isolepis prolifera.*

Economic benefits

There are a number of direct and indirect economic benefits of native vegetation such as wildflower, honey or essential oil production, timber harvesting, stock and crop protection (e.g. windbreaks), and increased

aesthetic appeal and resale value. For a more complete list of these benefits, see Connell et al. (2000b) and the *Geographe Catchment Companion* (GeoCatch, 2004).

The protection of the remaining native vegetation and the strategic revegetation of cleared land are considered to be the best ways of achieving the twin goals of sustainable agricultural production and nature or biodiversity conservation (Hussey and Wallace, 1993, cited in Connell et al. 2000a).

Weed invasion

Large numbers of weeds were found during the foreshore surveys. Most of these are shown on the maps contained in Chapter 6. Disturbance through clearing, grazing, erosion and modification of the channel provides ideal conditions for weed growth and spread. The main weeds of concern in the study area were Arum Lily, Bridal Creeper, African Cornflag, Gladioli, Pennyroyal, Dock, Agapanthus, grasses such as Couch and Kikuyu, and sedges such as *Isolepis prolifera* and *Juncus microcephalus*.

Weeds compete with native vegetation and restrict natural regeneration. They are a significant factor in the degradation of remnant vegetation and are a major threat to the biodiversity of the region. In addition, they are a major economic cost to agriculture.

All revegetation activities need to include strategic weed management actions to increase the survival rate of plantings and to reduce long term management activities. If grassy weeds infest a revegetation site, they will out-compete the native vegetation, and may cause a fire hazard.

5. Management advice

The information in this chapter is largely taken from *River Action Plan for the Sabina, Abba and Ludlow Rivers* (GeoCatch, 2002) by Genevieve Hanran-Smith.

Due to the interrelated nature of land management issues, simple quick fixes will not work and will only waste resources including time and money. A range of prioritised on-ground and community education activities are required. This requires a clear vision for the future and strategic planning. Capel LCDC and GeoCatch will provide technical advice, support and financial assistance to help you implement best practice management on your property.

Where to start

The main principles for riparian management are:

- conserve the best areas first;
- then move on to those reaches showing signs of recovery; and
- then treat the more degraded parts of the system.

This advice applies to both individual properties and the river system as a whole.

It is most cost effective to protect areas still retaining native vegetation. These areas are the most stable and the most likely to regenerate naturally. Assisting natural regeneration is a lot cheaper and easier than starting from scratch to implement riparian vegetation and erosion control works.

Work on the more degraded parts will be easier if the river upstream is in good condition. Erosion and weed infestations impact on areas downstream.

Both the Vasse River Action Plan (GeoCatch, 2000) and the Geographe Catchment Companion (GeoCatch, 2004) contain excellent advice on planning a restoration and revegetation project. Parts of this advice are included in Appendix 3 of this plan. These principles and the lessons learnt from the implementation of other River Action Plans should be used during the planning and prioritisation of individual on-ground activities. Good communication and a considered and flexible approach are essential.

Stock control

The control of livestock access is the most important management tool in the protection and restoration of waterways and vegetation. Fencing is the best method to achieve this.

APACE Green Skills & Pen (1997) provide some good advice with regard to the placement of fences alongside waterways. This advice is detailed below.

'Ideally, fences should be placed above the river valley (Figure 4). Depending on the steepness of the embankment, the fence should be placed 5 m to 20 m back from the edge of the river valley (Figure 4 A). Five metres is sufficient for a shallow valley a couple of metres deep but a broader zone, greater than ten metres, is required for valleys deeper than five metres. The purpose of fencing off the shoulders of the river is to enable trees on the upper part of the embankment and those above the river valley to anchor the adjacent land, and thereby prevent subsidence.

In the case of shallow river valleys, there is little chance that embankments will subside. Nevertheless, fence-lines should be located above the river valley (Figure 4 B). This is because fences and firebreaks located within the river valley will be damaged and eroded by floodwaters. When they occur, firebreak washouts can be severe and contribute large quantities of sediment to the river system.

If the river valley is particularly broad and floodplains have been cleared for grazing, fencing them off may mean sacrificing good farmland. In this case it is necessary that only those areas that are prone to water erosion or stock damage, such as embankments and secondary river channels which only flow strongly at times of flood, need to be fenced off (Figure 4 C). Some of these fence-lines will be prone to flood damage, but this can be minimised if fences run, as much as possible, parallel to the direction of floodwaters.

In the flatter and broader valleys it may be acceptable to use fences to control the level of grazing rather than to exclude it altogether. A careful watch would need to be kept to ensure that the grazing is sustainable and is not so heavy as to prevent the regeneration of native trees, shrubs and sedges.'

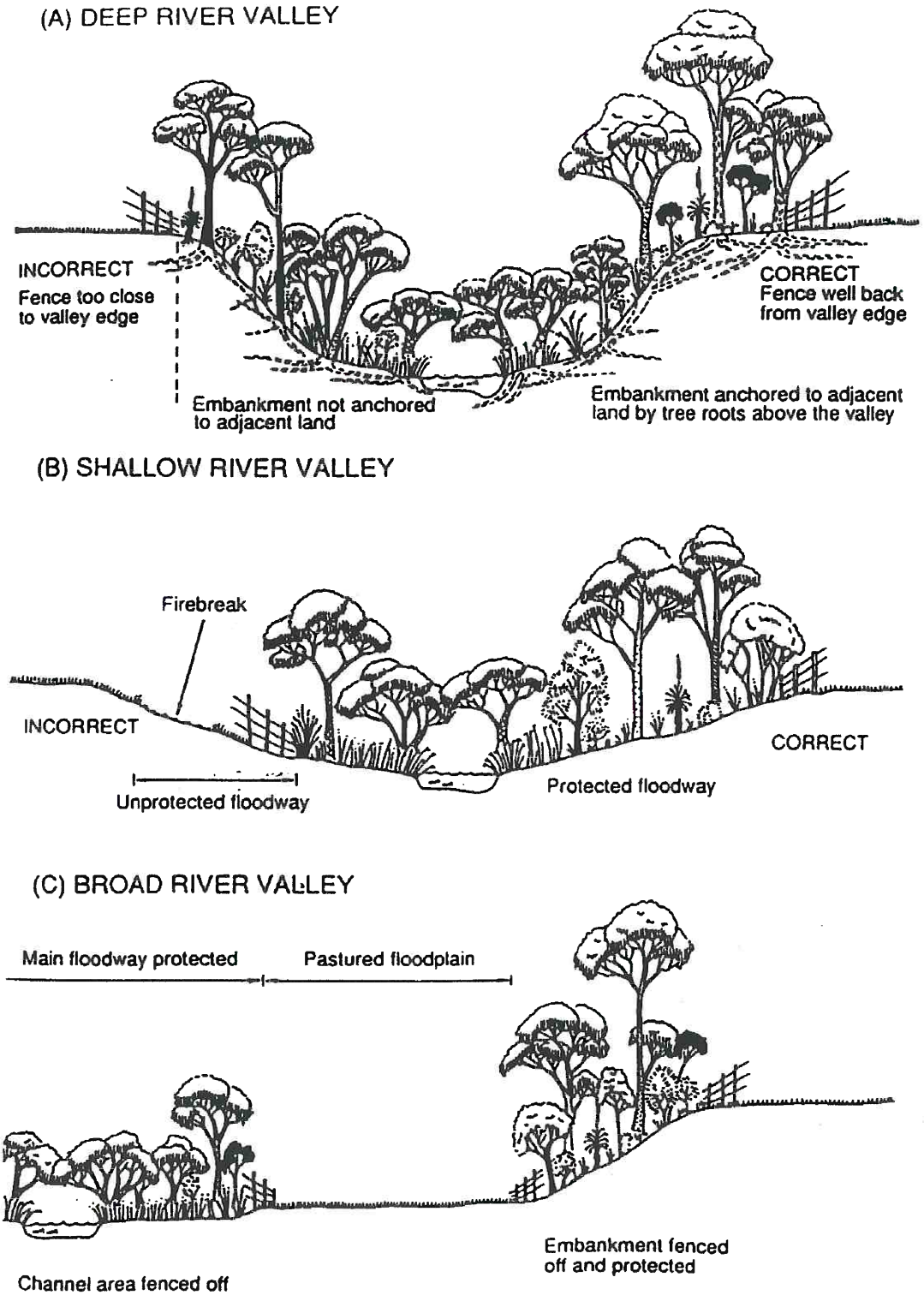


Figure 4: The correct placement of fences in relation to the river valley: (A) the deep river valley, (B) the shallow river valley and (C) the broad river valley with broad floodplain (APACE Green Skills & Pen, 1995).

Fencing may be used to exclude stock entirely from the river, or to allow restricted grazing. Once native species have regenerated or been re-established it may be appropriate to allow careful grazing for short periods to control weeds. Grazing may also be used to control weeds prior to planting. Heavy grazing that would degrade the riparian zone and ultimately eliminate native plant species should be avoided. Total exclusion of stock will be necessary where the bank is steep and sandy, or prone to collapse, or where the objective is to maintain high quality riparian habitat. In these cases, vigilance will be needed to pre-empt any serious weed invasions.

The provision of off-site or restricted access watering points and crossings may be required if the river is to be fenced. Information on design and construction of crossings and watering points can be found in the references listed below, or from your Landcare Officer.

Useful references on stock control

- Water and Rivers Commission Water Note 18, *Livestock Management: Fence location and grazing control.*
- Water and Rivers Commission Water Note 6, *Livestock Management: Construction of livestock crossings.*
- Water and Rivers Commission Water Note 7, *Livestock Management: Watering Points and pumps.*
- Water and Rivers Commission Water Note 19, *Flood proofing fencing for waterways.*

Water quality

Waterways in agricultural areas receive large quantities of nutrients, either dissolved in water, adhering to small soil particles eroded from the land or contained within dead plant and animal material, including manure washed from paddocks. Outlined below are a number of ways to minimise soil erosion and nutrient loss and their impacts upon waterways (Pen, 1999).

Vegetative buffers

Vegetated buffers alongside waterways can intercept and slow runoff and thereby trap suspended sediment, including organic material. Research has shown that vegetative buffers 10-50 m wide can achieve phosphorus and nitrogen filtration rates in the order of 50-100% (Pen, 1999). A vegetative buffer need not be of native vegetation and can be a simple grassy strip that is fenced off to control grazing. The nutrients assimilated by the vegetation can be utilised by crash grazing or preferably in hay production since the latter does not involve livestock returning nutrients to the grassy border as urine and manure.

Vegetation within the waterway itself forms a longitudinal buffer which, similarly, slows the flow rate, reduces erosion and traps soil, sediment and organic matter.

Farming practices (from Kingdon, 2000)

In reducing soil erosion, the key is to keep reasonably high levels of vegetation on the soil for as long as possible, and especially during times of high erosion risk. Achieving these conditions requires:

- use of reduced tillage and direct drilling;
- use of crop and pasture rotations that include well-managed perennial grasses and legumes;
- in row cropping, use of permanently raised beds and controlled traffic;
- managing organic matter by retaining stubble and including pastures in a crop rotation; and
- ensuring vigorous plant growth through appropriate soil, crop and water management.

Cultivation along the contours, rather than perpendicular to them, will slow the rate at which water flows across the land, reducing soil erosion by as much as 50% (Pen, 1999).

Soil testing and fertiliser use

Fertiliser is generally applied according to traditional practice, usually some time before the winter/spring growing season. Today, we know that after a number of years of fertiliser application, many soils are rich in nutrients but may be deficient in a few trace elements (Pen, 1999). Soil should be tested to determine fertiliser requirements and avoid excess application of nutrients, a portion of which will find their way into waterways.

Mycorrhizal and soil bacteria testing is another related tool. Past farming practices have led to the gradual sterilisation of soils. Soil organisms interact with the root hairs of pasture and native plants and assist with nutrient uptake. Different subsoil environments across even a small farm can relate to different yields for different parts of the pasture with subsequently different management requirements. Management practices to improve the health of soils and thereby increase farm profit are being trialed by the Lower Blackwood LCDC (J Hasler, pers. comm., 2003).

Useful references for protecting water quality through farming practices

Kingdon, B.K. (2000) *Fertiliser Use Guidelines for the Swan Coastal Plain of WA*. Vasse-Wonnerup LCDC, Busselton, WA

Prosser, I., Karssies, L., Ogden, R. & Hairsine, P. (1999) 'Using buffers to reduce sediment and nutrient delivery to streams'. In: *Riparian Land Management Technical Guidelines: Volume Two: On-ground Management Tools and Techniques*, Price, P. & Lovett, S. (eds). LWRRDC, Canberra.

Erosion control

Erosion is an issue requiring urgent attention along Gynudup Brook and Tren Creek, with many areas showing signs of severe undercutting and bank slumpage.

It should be noted that a detailed river geometry survey and a variety of calculations are usually required for the correct design of engineering works. It is also important to remember that rivers are part of a dynamic system, that is, they are in a constant state of change. Care should therefore be taken when attempting to predict the outcome of alterations to channel form and capacity. Site-specific technical advice should be obtained prior to commencing any form of physical modification to the river channel. The Capel Landcare Officer and engineers from the Department of Environment can assist with providing technical support.

A number of approaches to erosion control as outlined in the Capel River Action Plan by Kirrily White and Sarah Comer are discussed below (GeoCatch, 1999).

1. Point bars

Once a riverbank becomes disturbed to the point where it is actively eroding, there is large potential for this erosion to create further erosion downstream through the formation of point bars. Currents remove material from the outside banks of meanders and deposit it on the inside banks where water moves more slowly, forming a point bar (Raine & Gardiner, 1995). Over time these sand bars trap more sediment and continue to accumulate, to a point where they may even start to support in-channel vegetation growth. Some point bars are located and shaped in such a way that they actually divert the river flow onto the opposite bank further downstream, thus creating a new erosion point on the next outside bend. This cycle of erosion and deposition often continues downstream, and is a classic sign of a river in which the hydrological balance has been disturbed (Figure 5).

Removal of point bars may sometimes be needed in order to halt the progression of the erosion downstream. Generally, this should be undertaken in conjunction with other forms of restoration and care must be taken not to exacerbate the disturbance to the river channel. As discussed previously, a detailed river geometry survey of the localised problem areas is essential before this type of restoration procedure should be contemplated.

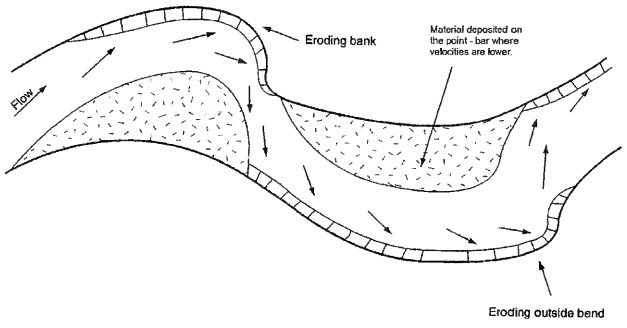


Figure 5: Outside bend bank erosion – Arrows mark the direction of flow showing that outside bends have the greatest erosion potential, so the meanders migrate downstream (Raine & Gardiner, 1995).

2. Undercutting

Undercutting often occurs in conjunction with the formation of point bars. Material is scoured from the toe of the bank, resulting in loss of bank support; this

often results in subsidence as illustrated in Figure 6 (Raine & Gardiner, 1995). Previous experience has shown that supporting and protecting the toe of the bank can prevent undercutting. Generally undercutting will occur where there is a meander. If this is the case, only the outside bends need to be supported as the flow velocity on the inside bend is much lower. Once an outside bend is stabilised, the corresponding inside bend will usually adjust its width to cater for the change in flow.

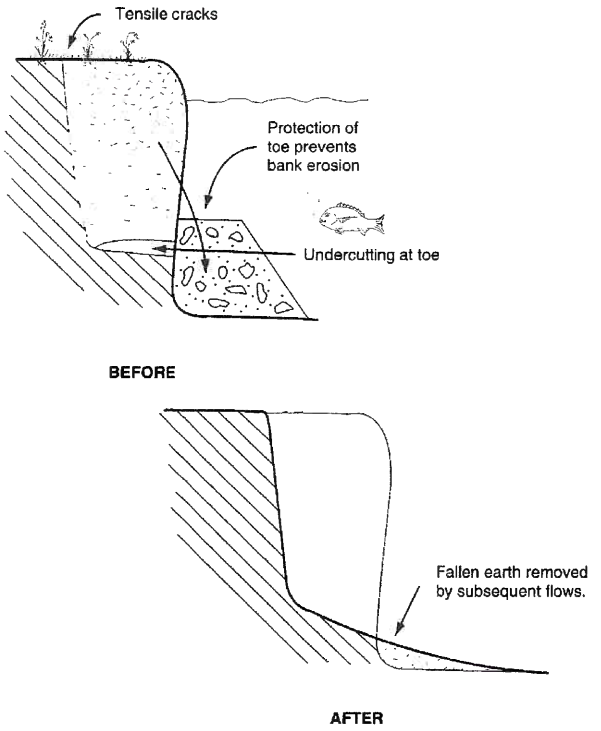


Figure 6: The use of structural works, such as a rock toe, will prevent the process of undercutting (adapted from Raine & Gardiner, 1995).

3. Bank slumping

Bank slumping can occur when poorly drained material within the bank becomes heavy with saturation and collapses into the river channel (Figure 7). This can occur with or without prior undercutting. It will often occur in response to the loss of native deep rooted riparian vegetation which is critical to bank stability. The best way to manage this problem is to exclude stock with fencing set well back from the river channel, and revegetate the foreshore with suitable species. Raine and Gardiner (1995) provide the following advice on this process:

- Replant the toe with species that can withstand high flow velocities (e.g. native sedges). This replanting should be dense with spaces between plantings of less than 1 metre;
- Replant the middle to upper bank areas with fast growing, deep rooted trees and large shrubs. These will hold the bank together, enhance drainage and remove excess moisture through transpiration;
- Vary the species that are planted to ensure differing root structures; and
- Extend plantings from the toe to the floodplain. If a narrow band of trees is planted, this may serve only to add to the weight of the bank without providing the necessary network of root support.

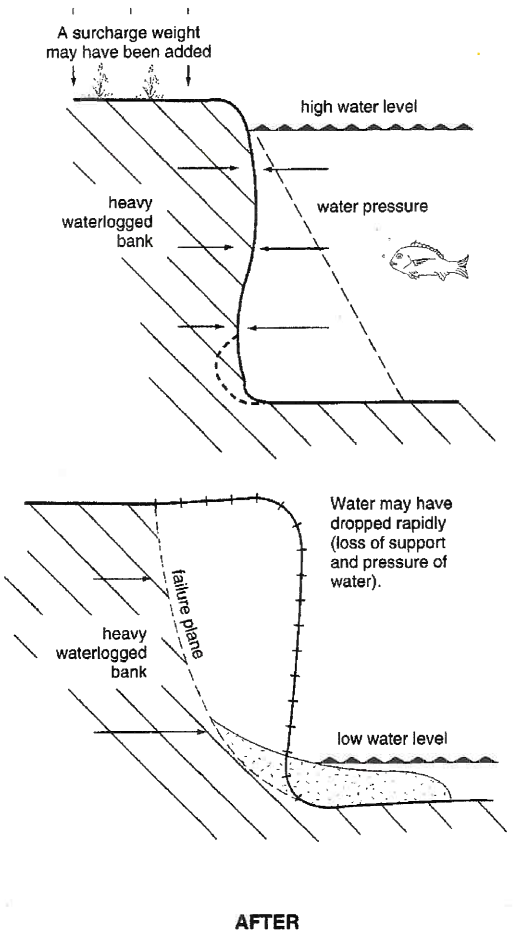


Figure 7: The process of bank slumping caused by excessive weight and lack of support (adapted from Raine & Gardiner, 1995).

4. Large woody debris

Snags, or large woody debris, are a natural component of the river system. They play an important role in the river ecology by providing a range of flow conditions within the channel and habitat for aquatic life forms. Occasionally snags can divert the flow onto the bank and subsequently cause erosion in areas lacking support from native vegetation. While de-snagging rivers has been a common practice in the past, the current management emphasis is to leave as much woody debris as possible. Rather than removing large woody debris from the channel, it should be repositioned at an angle 20° to 40° to the stream bank (Figure 8). This action will minimise the effect of the snag on flow levels and direction, whilst maintaining the habitat available for plants and animals that benefit from low flow conditions. Large woody debris can also be added to deflect flows from unstable areas.

Useful references on erosion control

Pen, L.J. (1999) *Managing Our Rivers*. Water and Rivers Commission, Perth.

Water and Rivers Commission (2001) *Stream Stabilisation*. River Restoration Report No. RR 10.

Raine, A.W. & Gardiner, J.N. (1995) Rivercare — *Guidelines for Ecologically Sustainable Management of Rivers and Riparian Vegetation*. Land and Water Resources Research and Development Corporation, Canberra.

Regeneration and revegetation

In areas that still retain native trees and understorey, natural regeneration is the cheapest and easiest management option. Control of stock access and invasive weeds is essential to this strategy, and should be the first step taken. Natural regeneration can be assisted by making small piles of branches and burning to promote germination through smoke and heat. Smoke water can also be applied to encourage germination. Another technique to assist regeneration involves laying the seed bearing parts of native plants directly onto the ground, allowing seeds to fall from them. This is called brushing, and works best after weed control measures such as spraying to reduce competition once the seedlings start growing.

Sections of riparian vegetation that have been heavily grazed and cleared generally contain more weeds and have a diminished seed bank. Options for these areas include: direct seeding; brushing with woody natives that contain seed; pre-seeded matting; and planting of

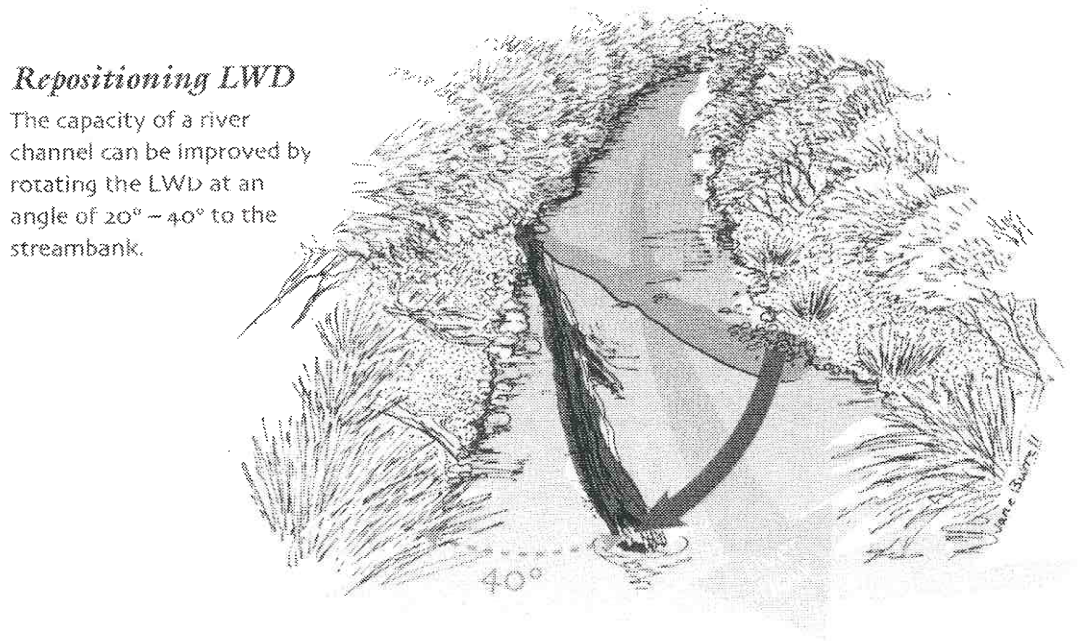


Figure 8: Repositioning large woody debris (Gippel et al, *1998).*

tube stock. The riparian zone should be planted in a wide band with a diverse suite of species including trees, shrubs, sedges, rushes, herbs and native grasses. This not only improves the habitat value of the foreshore, but also provides a matrix of different root structures that will improve bank stability and assist in erosion control. Where possible, seed should be collected from nearby representative remnant vegetation communities, as this will ensure that the species used are suitable, local and part of the existing ecological web. Appendix 1 provides a list of species that were found in the area. Species for revegetation projects in the Gynudup Brook and Tren Creek catchments should be selected from this list, choosing plants that are represented in nearby communities.

Good site preparation is crucial to successful revegetation. Elements that need to be considered are weed removal; soil amelioration; and preparation of the soil surface for direct seeding or planting. Ongoing pest and weed control will need to be factored into the project. Planting and sowing at the right time of year and at the appropriate depth will influence the success of the revegetation effort. The different revegetation techniques are outlined below.

Direct seeding

Direct seeding involves placing seeds directly on or into the soil on the site, either by hand or with machinery. For individual farm sized projects a mix of local seeds can be prepared in clean (weed free) sand and sown into lightly cultivated soil. For an increased cost but higher success rate, tree bags can be placed over these seeds to protect seedlings that emerge from dehydration, wind and predation. These bags will also help to identify and protect plants during follow-up spot spraying for weeds over the coming spring and summer. Several areas in the catchment have been identified as having good potential for the collection of local provenance seed. More information on seed collection and propagation is available from your Landcare Officers.

Direct seeding has a few distinct advantages over other revegetation methods:

- it is less time consuming and requires less labour than planting tube stock;
- a mixture of trees, shrubs, sedges and groundcovers can be planted at the same time, resulting in a plant community with a more natural look, and better resilience due to increased diversity and synergy;
- seeds will germinate over several years, giving a range of ages and growth forms, resulting in a more natural look;
- it is less expensive than using tube stock; and
- the natural root development of seedlings grown from seed usually results in plants developing deeper taproots, requiring less follow-up care.

However, direct seeding can be less reliable than planting, due to predation, specific germination requirements not being met, and poor conditions for direct seeding. Direct seeding may not be possible when high winds or strong water flow is present.

Planting

Planting is an appropriate technique for embankment and in-stream revegetation, and where direct seeding is difficult due to insufficient seed, excessive weed competition, or other factors. In these cases, nursery tube stock is ideally supplied from local provenance seed. A rule of thumb guide for planting densities is 500:50:5 herbs/sedges to shrubs to trees. When selecting plants and designing the revegetation of an area, it is also important to take into account the budget for follow-up management; the availability of water over summer; the range of species available; existing vegetation cover such as tree canopy; soil types; and the intended weed management approach.

Rushes and sedges should be planted in spring, when the water table is beginning to fall and the soil is still moist. Other seedlings should be planted when they are actively growing and the surrounding soil is moist and follow-up rain is likely (usually between May and July). Care should be taken to ensure that specimens are not root bound, and that minimal damage to the roots occurs when removing from pots. Planting requires significant prior planning, as it is best to collect local seed and contract a nursery to raise them in time for planting in the following wet season.

Brushing

Brushing is an excellent technique for use in all zones apart from the channel bed. This technique can be used to spread seed and assist with erosion control simultaneously. Brush should be harvested from plants at seed maturity and laid immediately on the revegetation site. Brush along the embankment should be secured in place. Species suitable for this technique are those that retain seed on the plant, but shed it when the plant dries out. This includes many of the myrtaceous species (peppermints, tea-trees, melaleucas, and eucalypts such as marri, jarrah and flooded gums). Brushing is an easy technique to combine with other revegetation activities such as direct seeding, and provides shelter to plantings, increasing seedling survival rates.

Pre-seeded matting

Pre-seeded matting involves sowing seeds onto an appropriate fibre mulch, and laying the mat on-site in early winter after germination. This technique is excellent for steep embankments, since it provides erosion control and revegetation in a single step. It is generally only suitable for seeding with rushes and sedges, since matting usually requires rolling for transport to the site once seeds have germinated (like instant lawn). It can be difficult to source matting with seeds of local provenance.

Division and transplanting of rushes and sedges

Many rushes and sedges propagate very well by vegetative division – plants can be easily split into individuals plants (ramets) every two months or so under good conditions. With planning the prior year and a small initial outlay, a large number of these difficult to propagate (from seed) species can be raised by division. Some species of rushes and sedges such as Juncus, Carex, Isolepis and Schoenoplectus are suitable for seeding, but generally only onto or under organic matting, due to weed competition and erosion issues.

Farmers often grub out rushes and sedges in paddocks as they may limit options for crop cultivation. In some circumstances, paddocks adjacent to restoration sites may contain large numbers of these rushes and sedges that could be transplanted with success. This can be a cheap, but labour intensive form of revegetation. Care must also be taken to ensure that not too many plants are taken to minimise erosion.

Useful references on natural regeneration and revegetation

Bradley, J. (1988) *Bringing Back the Bush: The Bradley Method of Bush Regeneration*. Lansdowne Press, Sydney.

Buchanan, R.A. (1989) *Bush Regeneration: Recovering Australian Landscapes*. TAFE Open Training and Education Network, Strathfield, NSW.

Scheltema, M. (1993) *Direct Seeding of Trees and Shrubs*. Greening Western Australia, Perth.

Kabay Rehabilitation Environmental and Biological Consultants (2002) *Native Plant Species to be Used in Stabilization and Enhancement of Water Corporation Rural Main Drains in the South West Drainage Districts*. Kabay Consultants Pty Ltd, Tuart Hill.

Water and Rivers Commission (1999) *Revegetation: Revegetating Riparian Zones in South-west Western Australia*. Water and Rivers Commission River Restoration Report No. RR4.

Water and Rivers Commission (1999) *Revegetation: Case Studies from South-west Western Australia*. Water and Rivers Commission River Restoration Report No. RR5.

Water and Rivers Commission (1999) *Using Rushes and Sedges in Revegetation of Wetland Areas in the South West of WA*. Water and Rivers Commission River Restoration Report No. RR8.

Water and Rivers Commission Water Note 20, *Rushes and Sedges*.

Revegetation of drainage channels

Many of the waterways in the catchment have been created or highly modified for drainage purposes. Revegetation of these drainage channels is required to reduce erosion and water quality problems like turbidity, nutrient enrichment and sedimentation. A number of landholders stated that they believed the water was being drained too fast, and that slowing of the drains would be beneficial. This indicates a distinct shift in landholder values over time.

Use of perennial grasses

Drains that have bare and exposed banks may have significant erosion problems due to the lack of roots holding the soil in place. In all circumstances, it is preferable to revegetate using a wide variety of local species, as this will achieve the objectives of increasing biodiversity as well as reducing erosion and improving water quality. However, there is not always the will or resources to revegetate using local species.

Where revegetation using native species is not an option an alternative method of reducing erosion and improving water quality should be considered. Fencing to exclude stock and the establishment of perennial grasses such as Kikuyu can be effective in trapping nutrients and increasing bank stability in some situations. Where the drain is very deep, steep sided, or fast flowing, grasses may not be effective. It should also be noted that shallow rooted perennial grasses will not be as effective in stabilising banks as a mix of trees, shrubs and rushes, especially in times of high flow or flood.

The use of perennial grasses to stabilise banks requires active management to ensure that there is no increased fire risk, and invasive weeds are controlled. Carefully controlled stock grazing can be an effective management tool. Crash grazing should be done in late spring and summer to minimise plugging and soil structure damage, and at no time should grazing result in exposed soil.

It is recommended that the LCDC develop a demonstration site to determine the effectiveness of perennial grasses to reduce erosion and trap nutrients. Monitoring of water quality parameters such as turbidity and nutrient levels could be used to indicate the success of the project.

Water Corporation managed drains

Some of the drains in the catchment are vested in, and managed by the Water Corporation. A significant proportion of these are not vegetated. These have the potential to become corridors of vegetation, thus providing valuable habitat and species diversity and richness. In these instances, the local landholder should work with the Water Corporation if they wish to implement revegetation projects. In the past, in parts of the south west, community groups have implemented a variety of streamlining projects on Water Corporation managed drains. However, these projects have often occurred with inadequate consultation with the Water Corporation. This has led to a variety of issues, as inappropriate restoration works may adversely impact upon the Water Corporation's ability to comply with its statutory obligations with regards to drainage and flood mitigation.

It should be noted that ecological ideals do not always fit with drainage requirements. Drainage management requires easy vehicle and machinery access to the drain for maintenance purposes; on the other hand planting of species that reduce water flow and trap sediment reduces drainage capability. As a result, there has been some conflict between the Water Corporation and community groups who have revegetated managed drains.

A recent report (Kabay, 2002) addresses these issues and provides a compromise between revegetation projects and the statutory obligations of the Water Corporation. This report contains a list of species considered appropriate for planting near rural main drains, and advice on where and how they should be planted. A demonstration site utilising this report has recently been established on Ambergate Road near Busselton by the Water Corporation in collaboration with a local landholder and GeoCatch. This site will be monitored and evaluated over the next few years.

It should be noted that the recommendations by the Water Corporation limit revegetation projects. For example, there is to be no planting in the drain invert itself, and species that tolerate seasonal inundation are to be avoided as they may colonise the drain and reduce water flow.

For more information on this report, or advice on species or techniques for revegetating Water Corporation drains, contact the Drainage Division of the Corporation in Busselton. Copies of the report are available at:

http://www.watercorporation.com.au/publications/7/WaterCorp_drainage_veg_report.pdf

Weed control

Weed invasion of native vegetation is a major threat along Gynudup Brook and Tren Creek, and within the catchment as a whole. Fencing the rivers and restricting stock access will result in the need for extra weed control. Weed control must be coordinated across the whole catchment for any action to be really effective. In foreshore areas, removal or control of weeds must take account of the erosive power of water. Clearing weeds in an unplanned manner could result in erosion in the river channel. Weed control principles to keep in mind include:

- Weeds thrive in disturbed areas and bare ground.
- Fire promotes weeds. Burning a remnant that is weed infested can make the weeds worse, unless there is follow-up weed control and revegetation. Native plants cannot compete with the rapid regrowth of weeds, which then become a greater fire hazard.
- Aggressive perennial weeds that spread readily along riparian corridors should be eradicated first, for example, Arum Lily, Bridal Creeper, African Cornflag, and Pennyroyal.
- If weed control is carried out, revegetate to prevent further weed invasion in the bare soil.
- Some native plants look and act like weeds. Do not begin weed control until you are sure a plant is a weed.

Chemical control of weeds on waterways requires careful planning. Issues which must be considered prior to any type of chemical control include the effects of the herbicides on native flora and fauna, and the impact on water quality. If you decide to use a herbicide, choose one that is modified to reduce impact in waterways and wetlands, such as Roundup® Biactive over Roundup with a wetting agent. In surface or sheet erosion prone sites, spot rather than blanket spraying can help to reduce erosion from loss of weed cover whilst still providing opportunities for planting.

In some cases it may be appropriate to use restricted grazing to control weeds. Where banks are steep and sandy or prone to collapse, or where the objective is to maintain high quality riparian habitat, grazing should be avoided. However, where the riparian zone has a history of grazing and the exclusion of stock would lead to an explosion of weeds, maintenance of the zone by light grazing is an option. The landholder needs to keep a careful eye on the riparian zone to see that it has an adequate cover of a mixture of native and pasture plant species and that erosion is not occurring.

Troublesome major weeds should be identified at an early stage and eradicated immediately (Pen, 1999).

Specific notes on certain weeds

A number of declared weeds (according to the Agricultural and Related Resources Protection Act 1976) are found in the study area. They are: Apple of Sodom, Arum Lily, Blackberry, Narrow Leaf Cotton Bush, Prickly Pear and Double Gee. According to legislation, declared plants need to be controlled or contained depending on their status, and reported to your local Agricultural Protection Officer. More information on the requirements for control and treatment is available from Agriculture WA.

There are a number of other species that are of concern in the catchment. More information on these and how to control them is listed below. Other weeds of concern in the area include grassy species such as Kikuyu (*Pennisetum clandestinium*) and Couch (*Cynodon dactylon*), and rush-like species such as *Isolepis prolifera*, *Cyperus congestus* and *Juncus microcephalus*.

The information below is sourced from Southern Weeds and Their Control (Moore & Wheeler, 2002) and Bushland Weeds: A practical guide to their management (Brown & Brooks, 2002).

Southern Weeds is a useful guide to landholders in the south west and provides information on weed identification and control. It is available from Department of Agriculture offices. Also useful for weed identification is Western Weeds (Hussey *et al.*, 1997).

Agapanthus Agapanthus praecox

A succulent strappy leaved garden escapee from South Africa, Agapanthus is a perennial with similar

ecological requirements to Arum Lily, that is now naturalising in damp areas along Gynudup Brook. It is a weed of national significance. It seeds freely and the clumps can exclude all other vegetation. It has the potential to become a very serious weed in south west Western Australia (R. Randal, pers. comm., 2003). Prevent seed set yearly, and dig out clumps ensuring no root fragments are left behind. The most successful chemical control is likely to be Chlorsulfuron or Metsulfuron Methyl.

Arum Lily *Zantedeschia aethiopica*

A tufting perennial with dark green, shiny leaves arising from a tuberous root. Easily recognised by large white 'flower' with a central yellow column of minute male and female flowers. Toxic to stock. Berries are spread by birds and along watercourses. A serious threat to riparian vegetation. Slashing, if undertaken regularly over a long period, may be effective but is very time and labour intensive. Chemical control with Chlorsulfuron or Metsulfuron as flowers start to wither is most effective. Blanket or hockey stick wipers should be used near waterways to prevent spray drift or runoff.

Blackberry *Rubus spp.*

A perennial plant with arching prickly stems (canes) that was introduced from Europe as a fruit crop. Highly invasive, especially along creeklines. Mechanical control is difficult except for small infestations. Care must be taken to ensure that all root material is removed. Glyphosate (Roundup® Biactive) provides reasonable control in sensitive areas. Direct injection of herbicide into stems has proven successful for small infestations (A. Matei, pers. comm., 2003).

Bridal Creeper *Asparagus asparagoides*

A perennial climber with wiry stems that was introduced from South Africa as a garden plant. It is extremely invasive and spreads very rapidly, eventually smothering native vegetation. A variety of new bio-control methods seem to be having good results in the area. A small (2-3 mm long) leafhopper and a 'rust' (fungus) are available for release. Contact the Capel Landcare Officer or the Department of Agriculture for more information.

Bulrush *Typha orientalis*

A perennial emergent aquatic plant, native to the eastern states and Asia, up to 4 metres tall. There is also a native bulrush (*T. domingenis*) that is easily confused with *T. orientalis*, with the two readily hybridising. Both species were found during the foreshore assessments. Manual control through slashing in late summer and then drowning can be very effective, as can cutting the stem 15 cm below the waterline 2-3 times a year, including at flowering. Chemical control needs to be very carefully executed as the potential for runoff or drift into the water is very high. Roundup® Biactive could be used in late spring to summer.

Edible Fig *Ficus carica*

A large tree with distinctive lobed leaves and fleshy fruit. A garden escapee that tolerates damp conditions. Takes root readily from cuttings and root fragments, and birds and animals disperse seeds. Hand pull seedlings, inject larger specimens with 50-100% Glyphosate in summer.

Pennyroyal *Mentha pulegium*

A slightly succulent rhizomatous perennial that favours damp conditions such as along paddock drains and creeklines. Has a strong mint-like smell when crushed. Chemical control using high rates of Glyphosate when actively growing is effective.

Watsonia (Watsonia sp), **Gladioli** (*Gladiolus* sp) and **African Cornflag** (Chasmanthe floribunda)

These have been grouped together as growth form and control methods are similar. All are tufted bulbous species from South Africa with erect sword shaped leaves, with tall spike-like white, pink, yellow or orange flowering stems. Manual control can be effective in small areas but is very labour intensive and requires many years of follow up as cormels and bulbs break off and are left in the soil (A. Matei, pers. comm., 2003). Spraying with Glyphosate, or 2,2-DPA just prior to flowering gives best results. In sensitive areas, using a sponge glove or a hockey stick wiper is best.

The Capel LCDC is currently undertaking mapping of certain weeds on public land within the Shire. This will assist coordinated weed control, which is essential for effective weed management, especially of the aggressive species such as Bridal Creeper or Arum Lily.

More information on weed control is available from the Department of Agriculture or your Landcare Officer.

Useful references for weed identification and methods of control

Brown, K. & Brooks, K. (2002) *Bushland Weeds: A practical guide to their management with case studies from the Swan Coastal Plain and beyond.* Environmental Weeds Action Network, Greenwood, Western Australia.

Department of Agriculture (1999) *Wetlands not Weedlands.* Weed Note No. 1/99, Department of Agriculture, Perth, Western Australia.

Dixon, B. & Keighery, G. (1995) 'Suggested methods to control weeds'. In: *Managing Perth's Bushlands*, Scheltema, M. & Harris, J. (eds). Greening Western Australia, Perth, WA.

Hussey, B.M.J., Keighery, G.J., Cousens, R.D., Dodd, J. & Lloyd, S.G. (1997) *Western Weeds: A Guide to the Weeds of Western Australia.* Plant Protection Society of Western Australia, Victoria Park, Western Australia.

Hussey, B.M.J. & Wallace, K.J. (1993) *Managing Your Bushland.* Department of Conservation and Land Management, Como, Western Australia.

Moore, J. and Wheeler, J. (2002) *Southern Weeds and Their Control* Department of Agriculture, Bulletin No. 4558. Perth, Western Australia.

Water and Rivers Commission (1999) *Revegetation: Revegetating Riparian Zones in South-west Western Australia.*

Water and Rivers Commission River Restoration Report No. RR4.

Water and Rivers Commission Water Note 22, *Herbicide Use in Wetlands.*

Water and Rivers Commission Water Note 15, *Weeds in Waterways.*

Feral animal control

Rabbits were evident throughout the catchment. Rabbits severely impact on native vegetation and hinder regeneration and revegetation. Landholders and managers are encouraged to control rabbits through baiting, shooting, fumigation and destruction of warrens.

The value to native fauna of vegetated corridors along the rivers is undermined by the presence of foxes and feral cats. Large numbers of local landholders were concerned that foxes preyed on the young of waterbirds which have limited habitat options in the area. Baiting and shooting can control foxes. The effectiveness of fox and cat control is greatly improved if undertaken on a large scale, involving as many landholders as possible. The Capel LCDC is currently coordinating a catchment-wide fox control program for local landholders. Advice and assistance is available from the Capel Landcare Officer.

The issue of kangaroos came up a number of times during community consultation. It was widely felt that there is an excess number of kangaroos in the area as a result of increased food availability with the large expanses of pasture. Large numbers of kangaroos can adversely impact upon revegetation projects, and culling may need to be investigated. However, kangaroos are a protected species and landholders must apply to the Department of Conservation and Land Management for a licence before any action is taken.

General recommendations

It is recommended that landholders consider the following:

- Decide to retain and protect the remaining riparian vegetation of Gynudup Brook and Tren Creek, including along drains and tributaries.
- Fence the river to exclude stock permanently, or to achieve management that allows for bank stability and native vegetation establishment and protection.
- Use funding that is available to defray the costs associated with fencing or rehabilitation projects such as construction of stock crossings.
- Plant vegetation corridors that support the movement of wildlife and re-create their habitat. This includes working with neighbours to provide more continuous habitat for native fauna.
- Control weeds, particularly invasive species in the riparian zone.
- Consider widening the riparian zone in various ways; options aside from indigenous vegetation could include commercial timber trees, fodder trees, and commercial plantings of native shrubs for seeds, essential oils or flower production.
- Implement management techniques that minimise soil erosion and nutrient loss to waterways such as: buffer strips, soil testing and maximising vegetation cover on the soil.

It is recommended that the Capel LCDC consider the following:

- Encourage and support community efforts to fence the rivers to restrict stock access.
- Apply for further funding to continue to subsidise the cost of revegetation projects and fencing.
- Encourage, as a priority, the protection of areas of the rivers still retaining native fringing vegetation. It is more cost effective to protect these areas now than to restore them later after further degradation has occurred.
- Provide encouragement and support to landholders to undertake revegetation using a diverse suite of local native species (including trees, shrubs, sedges, rushes, herbs and native grasses).
- Expand and continue to support weed and feral animal control projects in the catchment.
- Extend the focus of management plans to include rehabilitation of the smaller drains and tributaries to achieve the greatest impact on stripping sediments and nutrients before they reach the river channel.
- Promote management techniques that minimise soil erosion and nutrient loss to waterways such as: buffer strips, soil testing and maximising vegetation cover on the soil.
- Work with landholders and engineers from the Department of Environment to address serious erosion and sedimentation problems in the catchment.
- Work with other community organisations and Ribbons of Blue to increase community awareness and knowledge of Gynudup Brook and Tren Creek, focussing on natural assets, values, and threats.
- Develop a catchment scale corridor program that creates and reconnects remnant vegetation corridors of importance to native fauna. This could be aligned with the Geographe Bay Remnant Vegetation Strategy and the Biodiversity Hotspot Protection program.

6. River Foreshore condition and recommendations for management

Figure 9 provides an index for the individual maps, and an overview of the condition of Gynudup Brook and Tren Creek. For a summary of this condition rating and percentage of each waterway that is fenced to exclude stock, please refer to tables 1 and 2 in the Summary section.

Maps 1 to 20 show Gynudup Brook and Tren Creek and adjoining land titles from their headwaters in State Forest 27 to the junction with the Capel River, west of Bussell Highway.

The maps show the foreshore condition of the waterways as assessed using the Pen-Scott method (see Chapter 3 of this report for details of the method of assessment). Also shown on the maps are fencing status, weeds and management issues. A fold-out legend is provided.

The background aerial photos of the maps were taken in 2000 - 2001.

Management recommendations

The notes accompanying each map contain background information and management recommendations.

A table of recommended catchment-wide priority actions is provided at the end of the maps section. These priority actions should be considered alongside the other recommendations listed for each map. Prior to specific actions being undertaken, consultation should occur with stakeholders and relevant agencies, such as the Department of Environment or the Water Corporation.

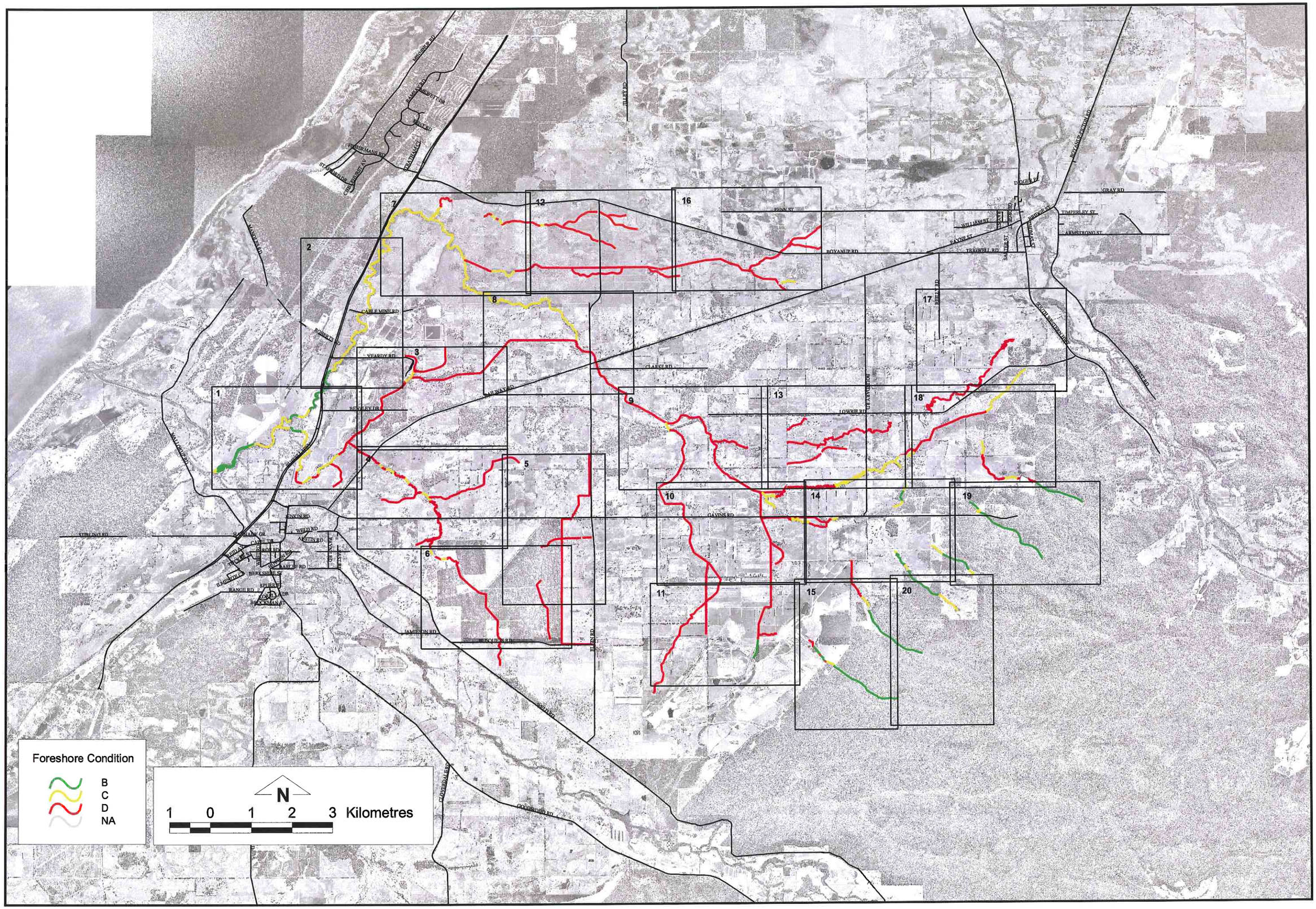
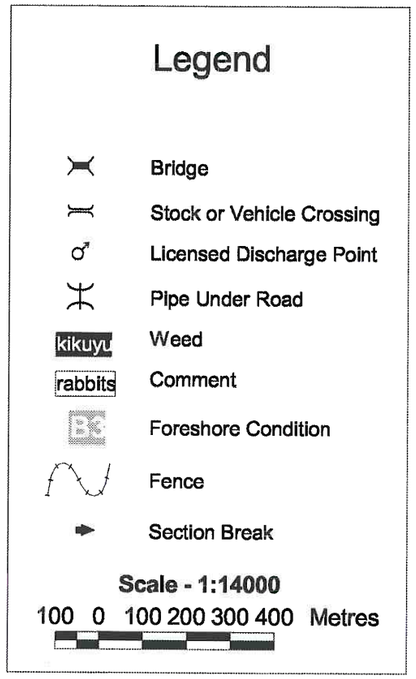


Figure 9: Index map



Map 1

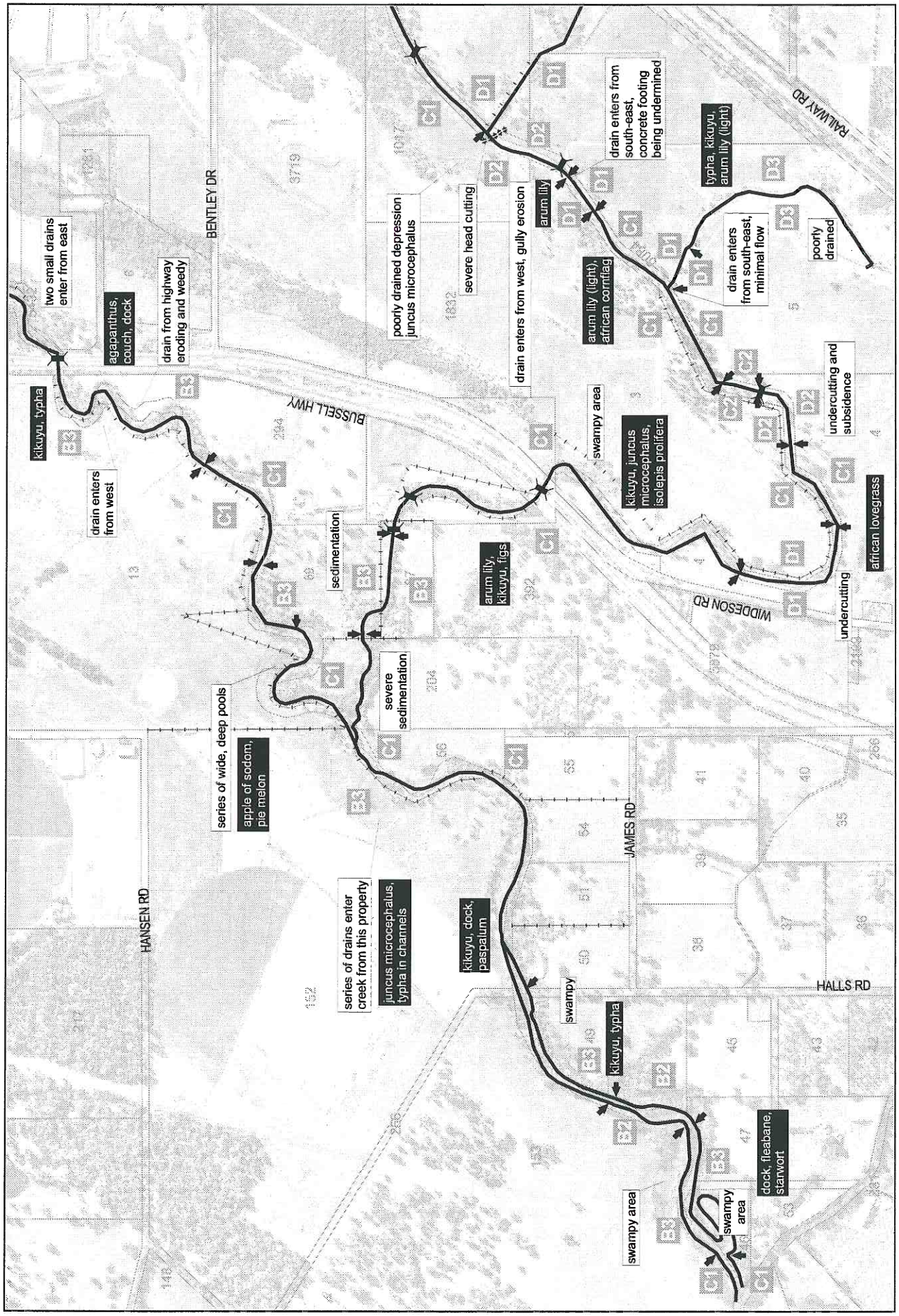
Map 1 shows Tren Creek entering Elgin Drain in the east of this section. Tren Creek (this part was straightened, deepened and de-snagged in the 1960s) then crosses under Bussell Highway before it joins Gynudup Brook, which then meanders south west until it joins the Capel River in the far south west corner of the map.

Land use in the area includes beef and sheep grazing, horse agistment, intensive horticulture, mineral sand extraction and processing, and hobby farms.

Issues	Comments
Fencing	Generally, Gynudup Brook and Tren Creek in this section are unfenced on one or both banks. In most cases, where fencing does exist stock have seasonal or complete access from the other bank.
Landform, soils and erosion	Tren Creek flows across the Bassendean Sands land system, where the soil type is a flat to very gently undulating sandplain with well to moderately well drained deep bleached grey sands with a pale yellow B horizon or a weak iron-organic hardpan at one to two metres. Tren Creek then joins Gynudup Brook which is flowing through the Pinjarra Plains land system where the main soil type is shallowly incised stream channels of minor creeks with deep acidic mottled yellow duplex soils. Nearby is a small strip of the Spearwood System that in this area comprises shallow to moderately deep siliceous yellowbrown and greybrown sands with limestone outcrops. Erosion is a significant issue in this section, with unstable banks and sediment being transported and deposited downstream.
Native Vegetation	Native vegetation remains along Gynudup Brook in this section, but, it is severely degraded in parts due to stock damage. Flooded Gums (*Eucalyptus rudis*) and Paperbarks (*Melaleuca rhaphiophylla*) with a diverse understorey of rushes and sedges such as *Juncus* spp and *Baumea articulata*, shrubs such as *Astartea fascicularis*, *Taxandria linearifolia*, and groundcovers are present. Tren Creek supports very little native vegetation, with an overstorey of Flooded Gums and Paperbarks present only in the western part. Little or no understorey remains.
Weeds	Annual grasses, Kikuyu, Dock, Arum Lily (isolated) Bridal Creeper (isolated), *Typha orientalis*, *Juncus microcephalus*, *Isolepis prolifera*, Pennyroyal, Apple of Sodom, Bushy Starwort (*Aster subulatus*), Agapanthus, African Love Grass, African Cornflag and Wavy Gladioli (isolated).
Other comments, special features	A drain from Bussell Highway cuts across Location 94, bringing large amounts of weeds and sediment into the main channel. On Location 46 a large Typha infestation has successfully been controlled in the last five years. There is severe sedimentation occurring in this area, particularly at the confluence of Gynudup Brook and Tren Creek. Remedial works upstream are required. The mosquito fish (*Gambusia holbrooki*) was found in large numbers in drains that flow directly into Gynudup Brook in Location 152. These exotic fish are a threat to native fish and frogs.

Map 1: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is important to protect what little remaining native vegetation exists. In particular, protection and enhancement of the remaining native riparian vegetation in this area is a priority, as little remains elsewhere in the catchment. Planting a variety of understorey species, including native rushes and sedges, is important. Current revegetation projects on Location 152 should be continued and expanded.
- Undertake feral animal control programs, as numerous rabbits were seen in this area.
- Work with DoE and the landholder to stabilise severe headcutting that is occurring on Location 1017 where Tren Creek enters Elgin Drain.



Gynudup Brook & Tren Creek Map 1

Map 2

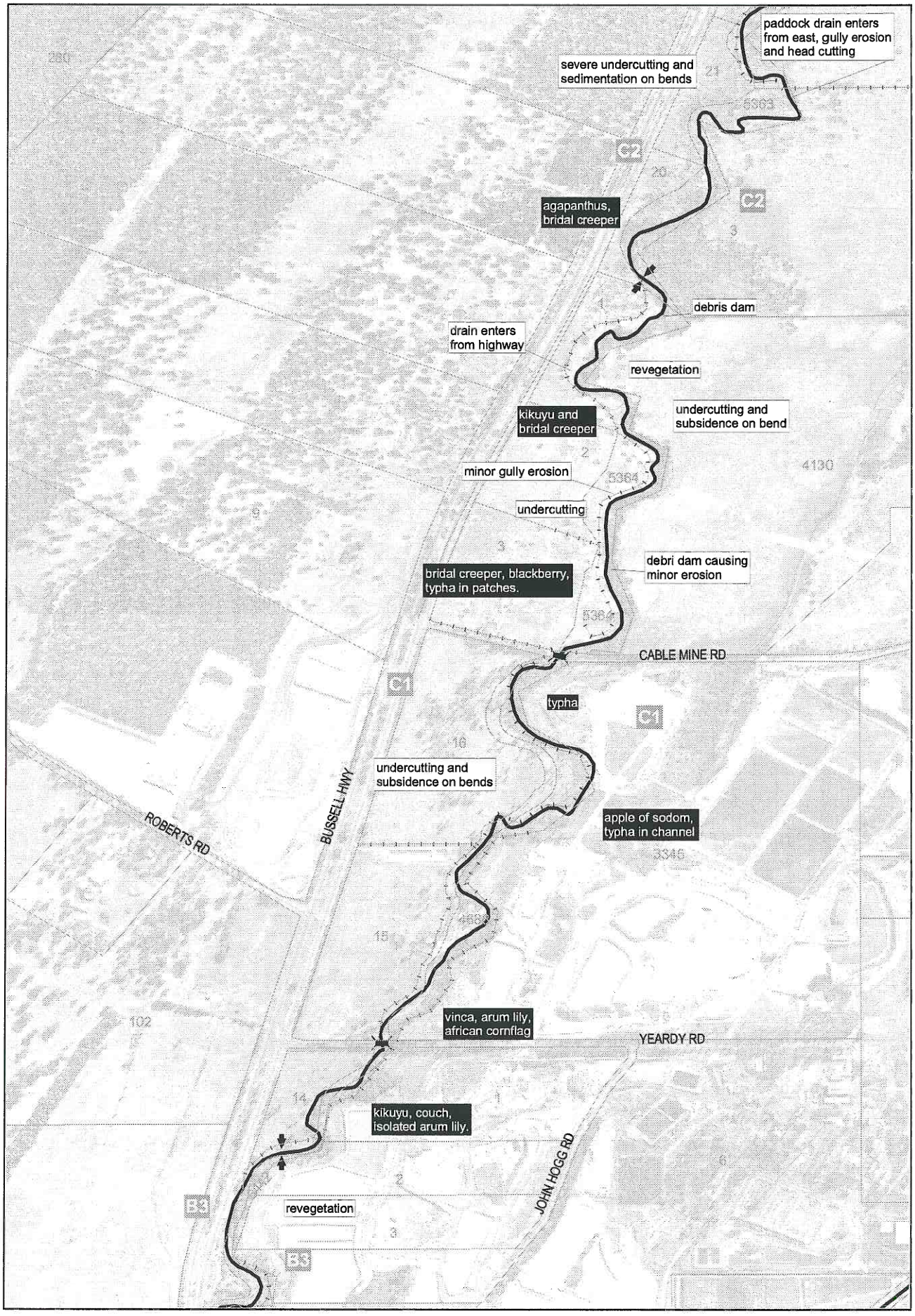
Map 2 shows Gynudup Brook following a meandering course in a southerly direction.

Land use in the area includes beef grazing, horse agistment, mineral sand extraction and processing, and hobby farms.

Issues	Comments
Fencing	Fencing in this area is generally incomplete, with grazing and stock access to one or both banks in Locations 20, 21, 3 (both Locations labelled 3), 16 and 14, and Drainage Reserve 5363. Elsewhere, fencing is complete or grazing does not occur.
Landform, soils	Gynudup Brook in this section flows across the Pinjarra Plain, with the main soil types being and erosion shallowly incised stream channels of minor creeks with deep acidic mottled yellow duplex soils; and poorly or imperfectly drained shallow pale sand to sandy loam over clays. Erosion occurs in this section, with banks frequently eroding on bends and sedimentation being transported and deposited downstream.
Native Vegetation	Vegetation in this section is relatively good, however some areas are degraded due to stock access. The northern portion is comprised of a Jarrah, Marri and Mountain Marri open woodland with a relatively healthy and diverse understorey of native rushes and sedges such as *Juncus* spp, some *Restionaceae* and shrubs such as Acacia and Melaleuca. The southern section comprised Flooded Gums (*Eucalyptus rudis*) and Paperbark (*M. rhaphiophylla*) with a diverse understorey.
Weeds	Agapanthus in northern section, Blackberry (isolated), Bridal Creeper, *Typha orientalis*, annual grasses, Kikuyu, Apple of Sodom, Vinca, Arum Lily (light), African Cornflag, *Juncus microcephalus*, and *Isolepis prolifera*.
Other comments, special features	Dumping of garden refuse, including edible fig, was noticed in one location in this area. This has the potential to take root and become a significant weed problem.

Map 2: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is important to protect what little remaining native vegetation exists. Protection and enhancement of the remaining native riparian vegetation in this area is a priority. Planting a variety of understorey species, including native rushes and sedges is important. Current revegetation projects should be continued and expanded.
- A number of landholders in this area have been planting a variety of species (primarily Bluegums Eucalyptus globulus) as wind and shelter belts or for aesthetic purposes. In future, local species should be used, and where possible an understorey should be established. Detailed information on windbreaks is available in the Geographe Catchment Companion (GeoCatch, 2004).
- Undertake feral animal control programs, as numerous rabbits were seen in this area.



Gynudup Brook & Tren Creek Map 2

Map 3

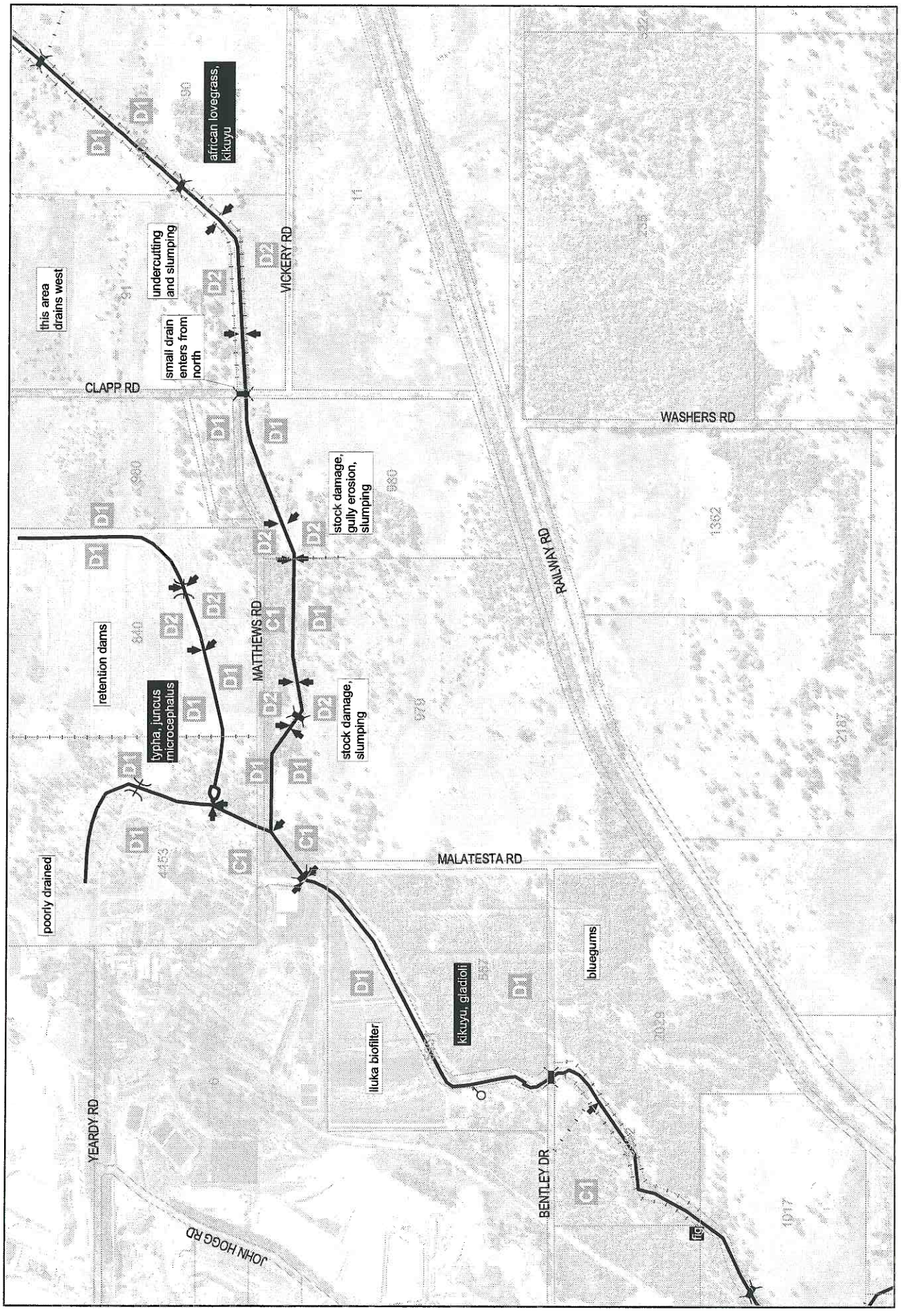
Map 3 shows the Elgin Main Drain entering from the north east, and flowing west across agricultural lands.

In the northern part of the map, a newly constructed drain runs adjacent to a series of holding dams. This is joined by a small drain that collects water from Location 91 and the north west portion of Location 90 before meandering south west and joining a smaller drain from the north, draining a small section of land north of Yeardy Rd. This then flows into the Elgin Drain via a steel pipe. Elgin Drain then flows south west, collecting flow from a licensed discharge point opposite Location 557.

Issues	Comments
Fencing	Both banks of the Elgin Main Drain are fenced in Drainage Reserve 406, however stock have seasonal access to both banks. In the south west corner of the map, Drainage Reserve 5952 is wholly fenced, excluding stock access at all times. Drainage Reserve 5951 is only fenced on the east bank, however there is no grazing on the west bank. Elsewhere, Elgin Drain is unfenced and grazed.
Landform, soils and erosion	Elgin Drain in this section flows primarily across the Pinjarra Plain with the main soil type being poorly drained flats, sometimes with gilgai microrelief and with moderately deep to deep, black, olive grey and some yellowish brown cracking clays and less commonly non-cracking friable clays, with generally acidic subsoils. A small section of Bassendean Sands is also present with extremely low to very low relief dunes, undulating sandplain and discrete sand rises with deep bleached grey sands sometimes with a pale yellow B horizon or a weak iron-organic hardpan at depths generally greater than 2 metres. Erosion is a significant problem in parts of this section, with banks eroding and large amounts of sediment transported downstream.
Native Vegetation	There are two patches of native riparian vegetation in this section. There is a small patch of remnant Marri, Peppermint and Banksia with limited understorey in the north of Location 979. West of Drainage Reserve 5952, there is a patch of Jarrah and Marri woodland with a diverse understorey. In Drainage Reserve 406 and Location 4453, a number of species including *Acacia pulchella*, *Melaleuca rhaphiophylla*, *M. lateritia* (Robin Redbreast Bush), *Viminea juncea* and rushes and sedges such as *Juncus pallidus*, are naturally regenerating due to reduced stock access.
Weeds	African Love Grass, especially in fenced-off drainage reserves, annual grasses, Kikuyu, *Juncus microcephalus*, *J. articulatus*, *Isolepis prolifera*, *Typha orientalis*, and scattered Wavy Gladioli (mainly in drainage reserves).
Other comments, special features	The waste water from Iluka's operations is fed through a large bio-filter that contains a number of native rushes and sedges such as *Schoenoplectus validus* and *Juncus pallidus*. This bio-filter is designed to strip nutrients, heavy metals and sediment from the waste water.

Map 3: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise damage and protect water quality.
- Continue and expand weed control programs.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is important to protect what little remaining native vegetation exists. Protection and enhancement of the remaining native riparian vegetation in areas such as Location 979 and west of Drainage Reserve 5952 is a priority. Planting a variety of understorey species, including native rushes and sedges, is important.



Gynudup Brook & Tren Creek Map 3

Map 4

Map 4 shows two branches of Tren Creek. The main branch runs in northerly direction, before being joined by a smaller branch that is flowing west. The main channel then meanders north west.

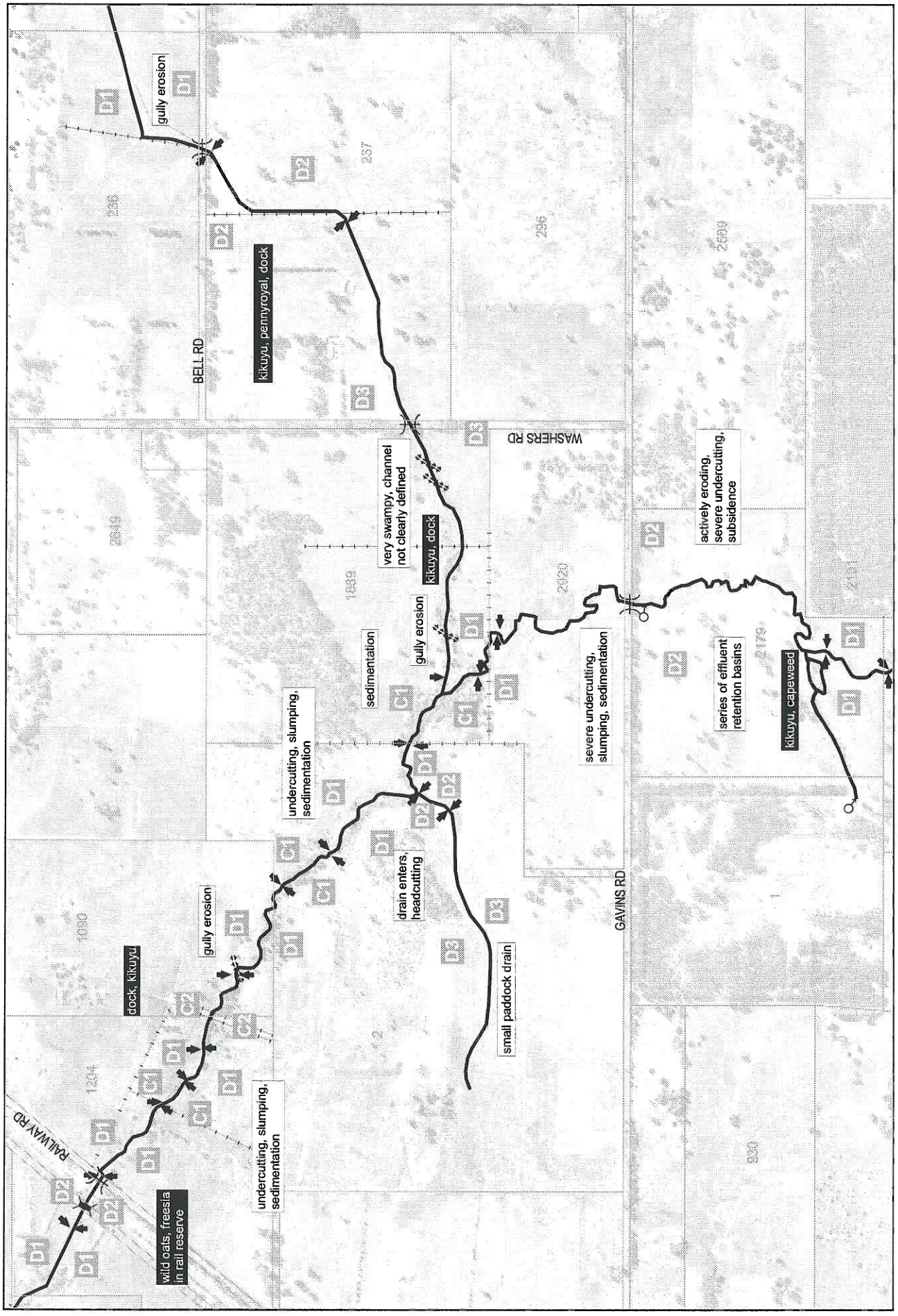
There is a series of effluent retention ponds on Location 2179, with licensed discharge points near the northern boundary of 2179 and the southern boundary of the adjacent Location 1. These are designed to allow liquid effluent from a dairy to settle and percolate through the soil, before discharging into Tren Creek. Location 1 is also used for effluent retention, with a Bluegum plantation irrigated with waste water. This was unsuccessful, and the majority of the trees have since died.

Land use in the area includes beef grazing, effluent retention, and tree cropping.

Issues	Comments
Fencing	Parts of Location 236 and 237 are fenced on one side of the waterway, however stock have access from the opposite bank. Elsewhere, there is no fencing to restrict stock access to the banks.
Landform, soils and erosion	Both branches of Tren Creek flow across the Pinjarra Plain in this area, with the main soil types being poorly or imperfectly drained shallow pale sand to sandy loam over clay; or very gently undulating terraces contiguous with the plain, with deep moderately well to well drained soils associated with current stream systems comprising of acidic red and yellow duplex soils, or less commonly gradational red and yellow earths. Erosion is a significant problem in this section, with banks in Locations 2920 and 2179 in particular freely eroding, and large amounts of sediment being transported downstream.
Native Vegetation	Little native vegetation remains in this section, with only a small patch of mature Flooded Gum (*Eucalyptus rudis*) and Paperbark (*Melaleuca rhaphiophylla*) with limited understorey, such as *Juncus pallidus*, found in Locations 1889, 2, 1090 and 1204. Limited regeneration is occurring in Location 1889, with grazing impacting heavily.
Weeds	Annual grasses, Kikuyu, Dock, Pennyroyal, Capeweed and Guildford Grass.
Other comments, special features	There is a major weed infestation in Washers Rd reserve, close to Bell Rd. Large amounts of Bridal Creeper, Arum Lily, African Cornflag, Jonquils, Freesias and African Love Grass were found. The water quality in parts of this section appears poor, with foul odours and excessive staining present. At the time of survey (18 Aug 2003) the monitoring wheel for the licensed discharge point in Location 2179 was broken. Additionally, the capacity of the retention ponds appear to be too small. The pond water was observed running over the northern edge of a number of ponds and discharging directly into Tren Creek approximately 5 metres upstream of where it goes under Gavins Rd.

Map 4: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is important to protect what little remaining native vegetation exists. Protection and enhancement of the remaining native riparian vegetation in Locations 1889, 2, 1090 and 1204 should be a priority. Planting a variety of understorey species, including native rushes and sedges, is important.
- Undertake feral animal control. Evidence of rabbits and foxes was common in this section.
- The LCDC should (with the assistance of landholders) implement a comprehensive water quality monitoring regime.



Gynudup Brook & Tren Creek Map 4

Map 5

Map 5 shows the start of one small branch of Tren Creek in the north west corner. It also shows the southern portion of a series of drains that flow roughly north into Gynudup Brook.

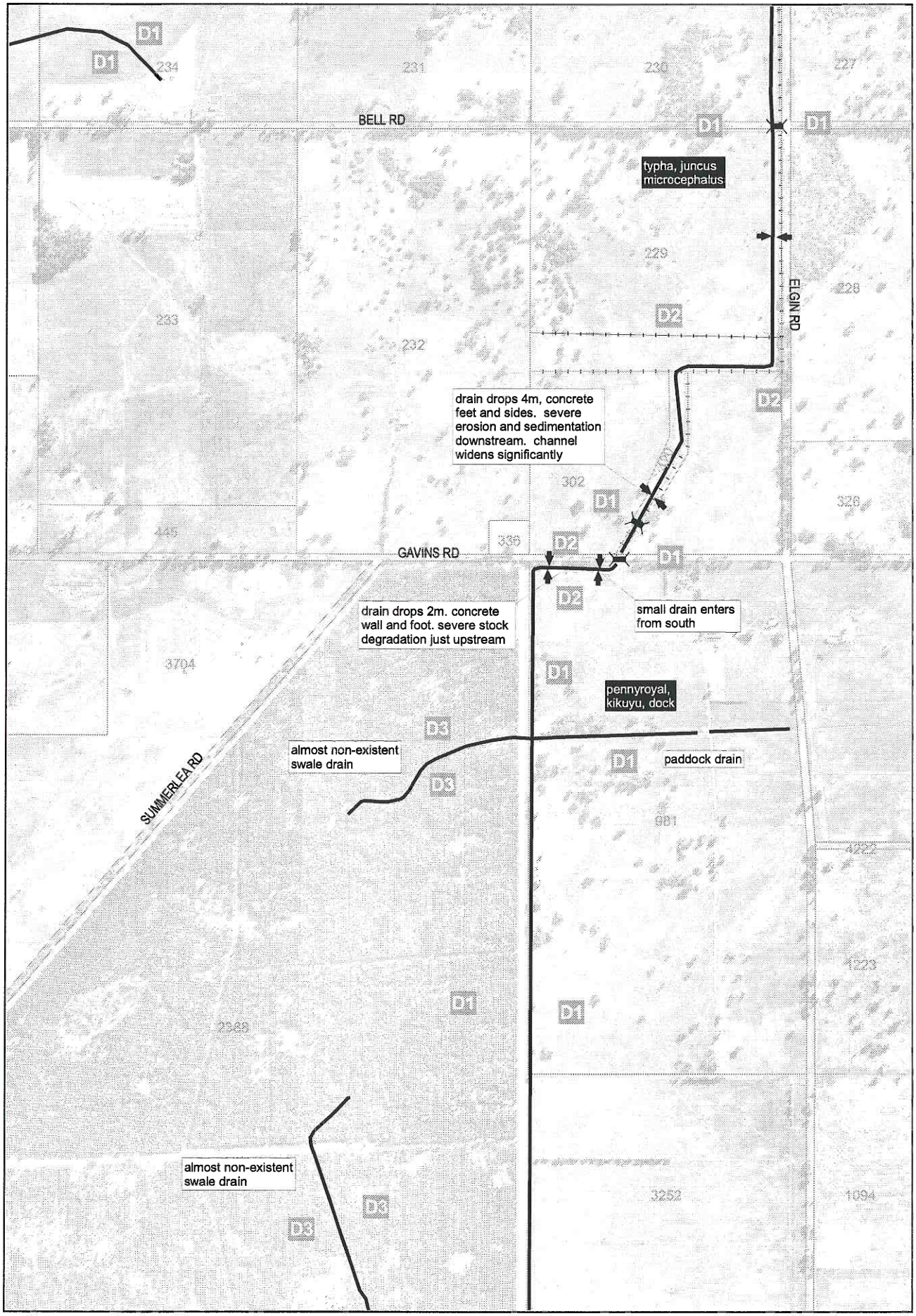
There is small drain that runs parallel to the boundary of Locations 981 and 2381 before flowing diagonally north east across Location 302 and then north parallel to Elgin Rd. When this drain reaches Gavins Rd, it widens and deepens significantly, becoming a large, deep, steep-sided agricultural drain.

Land use in the area includes tree cropping and beef grazing.

Issues	Comments
Fencing	The drain running along the boundary of Locations 981 and 2388 is completely fenced on the west bank, and partially fenced on the east bank, and stock have access to both banks due this gap in the fencing. Similarly, fencing on Locations 302, 420, 229, 230 and 234 is incomplete, and stock have access to both banks.
Landform, soils and erosion	The drain running north flows from the Bassendean Sands where the main soil type is a sandplain and extremely broad low rises with imperfectly drained deep or very deep grey siliceous sands. It then flows across the Pinjarra Plain, where the main soil type is imperfectly or poorly drained shallow pale sand to sandy loam over clay. Erosion is occurring in the northern part of this section, with banks eroding and subsiding due to undercutting and stock damage.
Native Vegetation	Very little riparian vegetation remains in this section; there is a healthy patch of Paperbarks (*Melaleuca preissiana*) and Flooded Gums (*Eucalyptus rudis*) with some understorey in the poorly drained land east of Elgin Rd on Location 228. There is some natural regeneration occurring adjacent to the drain on Elgin Rd. Elsewhere, isolated mature Flooded Gums, Marri and Jarrah occur.
Weeds	Annual grasses, Kikuyu, Dock, Pennyroyal, African Love Grass, *Typha orientalis*, *Juncus microcephalus* and *Isolepis prolifera* in the northern section of the drain.
Other comments, special features	Where Reserve 420 begins, the drain drops approximately 2 metres with concrete walls and footing. Immediately downstream, the drain is freely eroding and widening, with large amounts of sediment being transported downstream.

Map 5: Management recommendations and advice

- Continue to fence off the waterway, construct stable stock crossings and off-stream watering points.
- Continue and expand weed control programs.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. Planting a variety of understorey species, including native rushes and sedges, is important.
- Working with the Water Corporation and in consultation with DoE engineers, design and install erosion control measures in the drainage reserve on Location 420.



Gynudup Brook & Tren Creek Map 5

Map 6

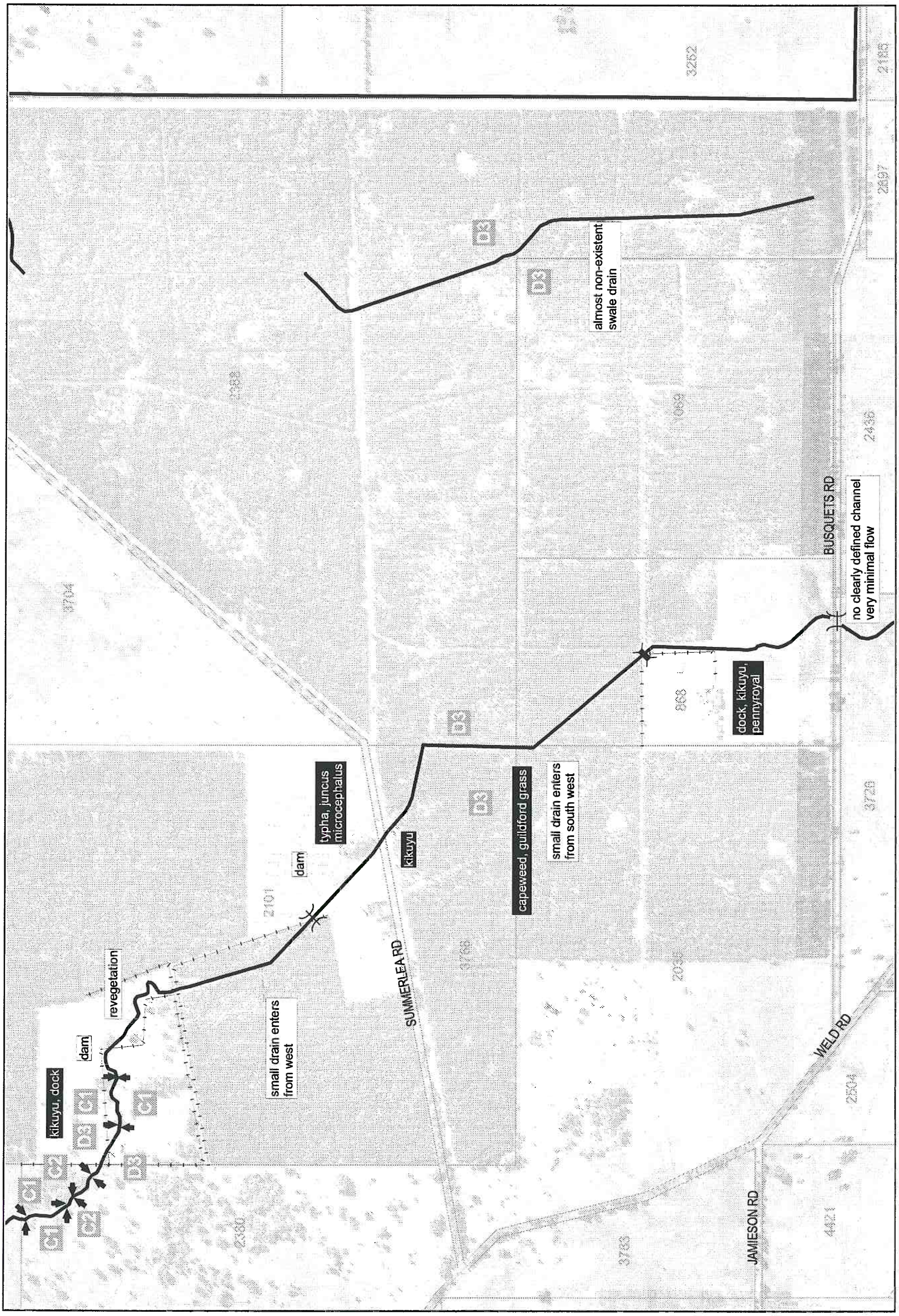
This map shows two small branches of Tren Creek. The eastern branch is a very small rarely flowing, swale type drain wholly contained within an almost mature Bluegum (*Eucalyptus globulus*) plantation. The western branch starts as a low-lying depression in an agricultural paddock before running north, northwest through the same Bluegum plantation - again as a narrow, barely flowing swale type drain. As it meanders north through Bluegums and agricultural paddocks, it picks water up from adjoining paddocks but remains small with minimal flow.

Land use in the area includes tree farms, beef grazing and a small vineyard.

Issues	Comments
Fencing	In areas where grazing occurs, fencing of the creekline is incomplete apart from a small section on Location 2101 which is fenced on both sides.
Landform, soils and erosion	These two branches of Tren Creek flow across the Bassendean Sands, with the main soil types being sandplain and broad extremely low rises with imperfectly drained deep or very deep grey siliceous sands; and closed depressions and poorly defined stream channels with moderately-deep to deep, poorly to very poorly drained bleached sands with an iron-organic pan, or clay subsoil with dark grey sand or sandy loam surface horizons. Erosion is not a significant problem, primarily due to the very low flow in this section.
Native Vegetation	Very little native vegetation remains in this section with isolated Flooded Gums and Marri occurring. There is some regenerating *Juncus pallidus* in Location 2101 near the dam.
Weeds	Annual grasses, Kikuyu, Pennyroyal, Dock and *Juncus microcephalus* in open areas, and Guildford Grass and Capeweed in the Bluegum plantations.
Other comments, special features	When cropping of Bluegums occurs, landholders will need to be aware of the potential for erosion due to increased water runoff.

Map 6: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Undertake feral animal control. Evidence of rabbits and foxes was common in this section.
- Continue and expand weed control programs.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is important to protect what little remaining native vegetation exists. Protection and enhancement of the remaining native riparian vegetation in Location 2380 should be a priority. Planting a variety of understorey species, including native rushes and sedges, is important.
- Expansion and continuation of the revegetation project in Location 2101 is important.



Gynudup Brook & Tren Creek Map 6

Map 7

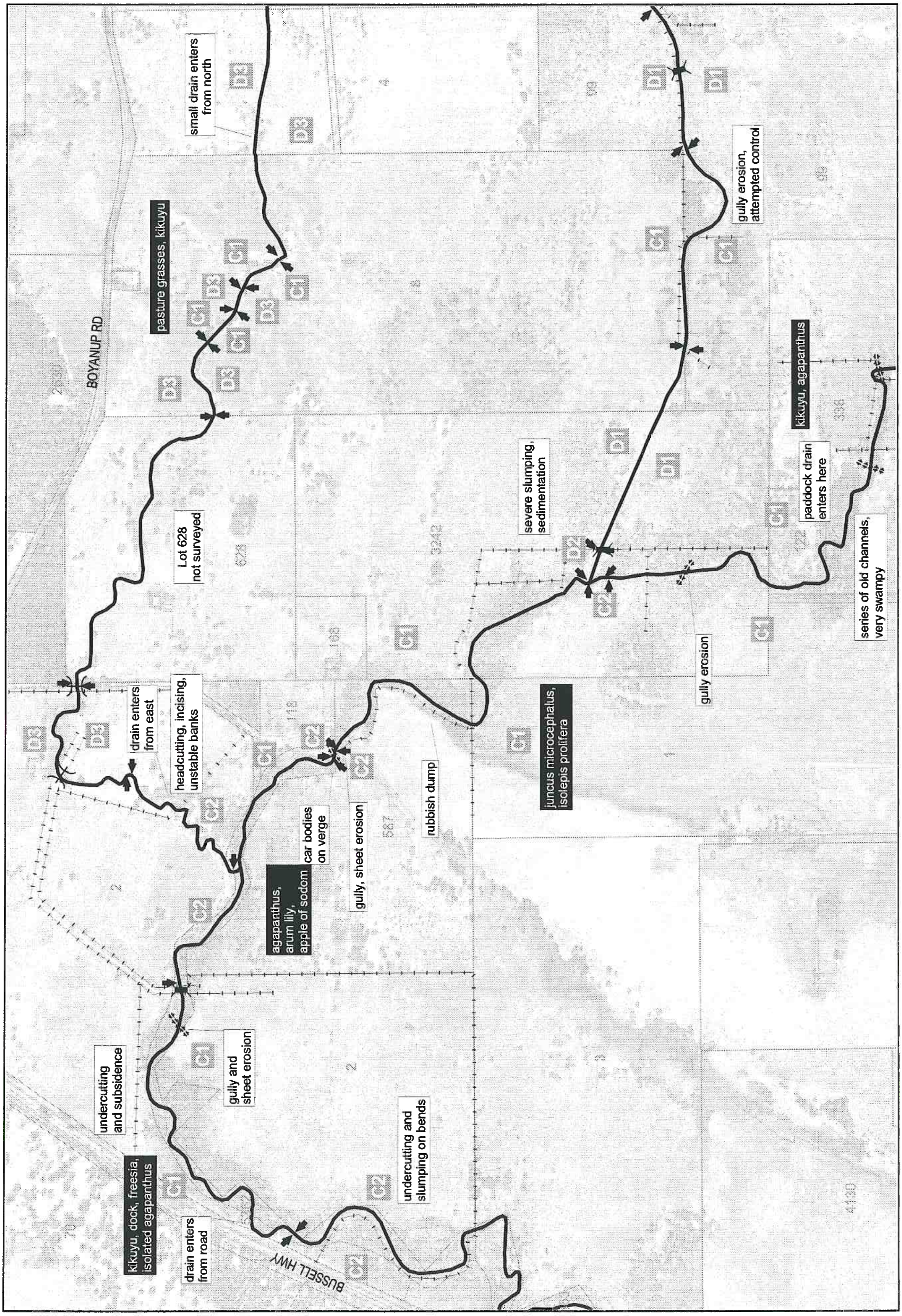
This map shows a number of branches of Gynudup Brook meeting in the north west corner of the map, before it meanders and begins to flow in a southerly direction. The main channel (prior to the construction of the Elgin Main Drain diversion – see Map 8) travels north with very little flow before an agricultural drain enters from the east, bringing with it considerable flow. This travels north west, before a small natural (but denuded of vegetation) creekline enters from the north, north east, bringing some additional minor flow.

Land use in the area includes beef grazing and dairying.

Issues	Comments
Fencing	None of these sections of Gynudup Brook are fenced on both sides of the bank. Where the creekline is fenced on one side (parts of Locations 2, 8 and 587) stock have access from the opposite bank.
Landform, soils and erosion	These branches of Gynudup Brook flow across the Pinjarra Plain, with the main soil types being shallow pale sand to sandy loam over clay that is imperfectly or poorly drained; poorly drained flats, commonly with gilgai microrelief and with deep black, grey to olive brown cracking clays with alkaline subsoils; or shallowly incised stream channels of minor creeks and rivers with deep acidic mottled yellow duplex soils. Erosion is a significant problem in this area, with banks often eroding on bends and sediment being transported downstream.
Native Vegetation	This section has significant patches of relatively healthy remnant native vegetation, within the southern section primarily Flooded Gum (*Eucalyptus rudis*) and Paperbark (*Melaleuca rhaphiophylla*) with very little understorey, and only occasional patches of native rushes and sedges such as *Juncus amabilis* and *J. pallidus*. The north western section contains mature Marri and Jarrah trees with little understorey.
Weeds	Annual grasses, Kikuyu, Arum Lily (light), Dock, *Juncus microcephalus*, *Isolepis prolifera*, African Love Grass, Apple of Sodom, Narrow Leaf Cotton Bush (isolated), and Agapanthus (in southern section).
Other comments, special features	A number of landholders in this area voiced their concerns about the decreased flows through this section of Gynudup Brook, stating that the diversion drain (see Map 8) took too much flow. Location 628 was not assessed. The landholder did not believe that they had any waterway relevant to the study on their property. From the property boundaries, the creek appeared as in Locations 2 and 8, a small grassed swale drain with very low flow and no significant erosion problems. Weeds likely to be found include annual grasses, Kikuyu and Dock. A rubbish dump was observed on Location 587, with numerous types of domestic and agricultural rubbish found on the bank and in the stream channel, including chemical containers, garden refuse and white goods.

Map 7: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs.
- Undertake feral animal control. Evidence of rabbits and foxes was common in this section.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is important to protect what little remaining native vegetation exists. Protection and enhancement of the remaining native riparian vegetation in this area should be a priority. Planting a variety of understorey species, including native rushes and sedges, is important.
- Working with engineers from DoE, design a simple, reliable, low maintenance structure to allow water to be diverted into the natural creekline at the Elgin Drain Diversion (Map 8) to improve environmental flows in this section of Gynudup Brook.
- Remove rubbish from Location 587.



Gynudup Brook & Tren Creek Map 7

Map 8

This map features the complete diversion of Gynudup Brook into the Elgin Main Drain, which was constructed around 1962. The diversion drain now takes all summer and winter flows (except in flood) in a westerly direction, bypassing the northern portion of Gynudup Brook in this section. The drain itself is a large, steep sided channel that has widened considerably since it was constructed; it runs year round, with summer flow possibly due in part to licensed discharges from upstream mineral sands extraction operations. The natural creekline does not flow in summer, and in winter there is only the minimal flow that is collected from adjacent paddocks. Upstream of the diversion drain, flow follows a natural watercourse that was de-snagged and deepened as part of the drainage works.

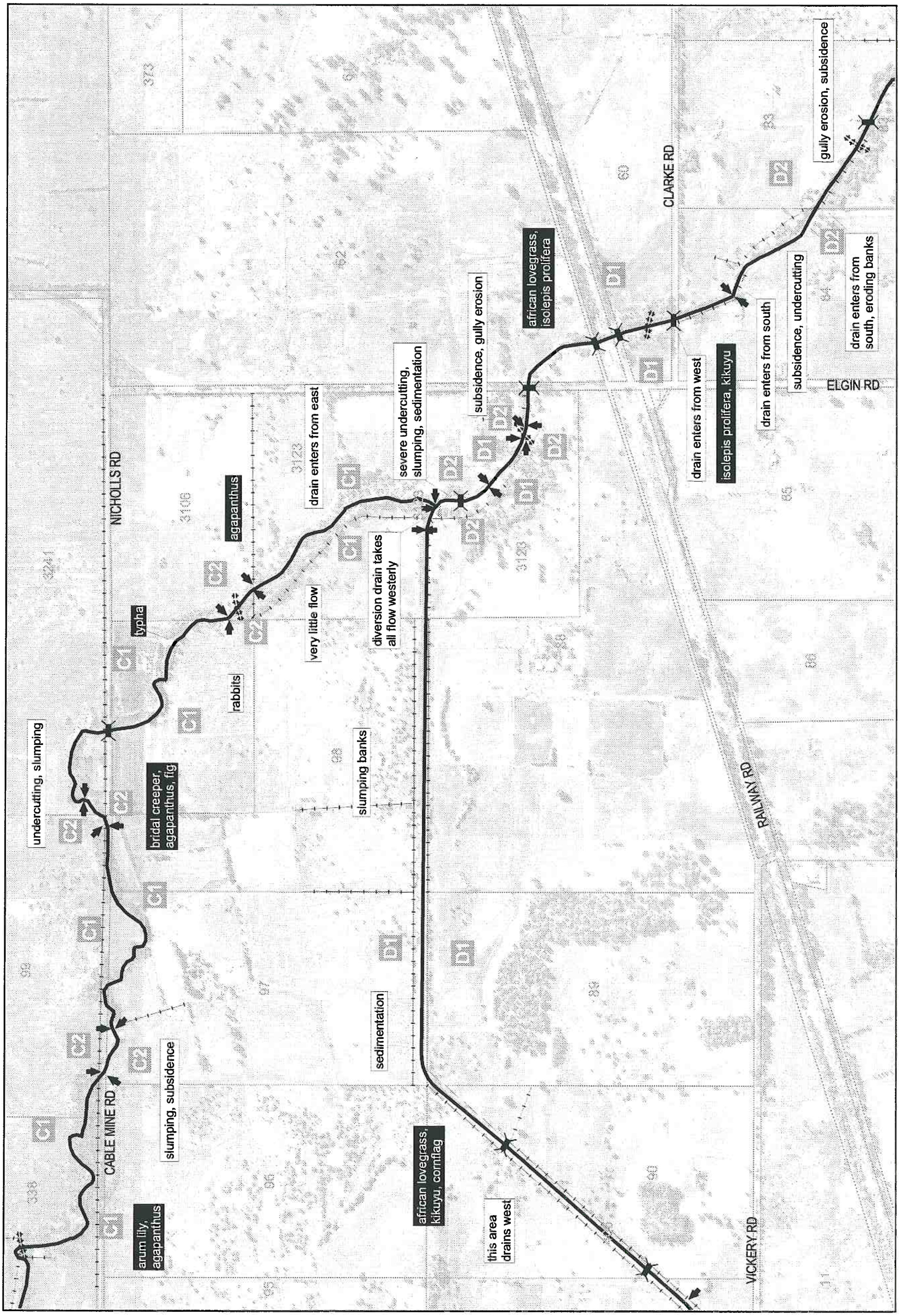
Land use in the area includes beef and sheep grazing, dairying, horse agistment and viticulture.

Issues	Comments
Fencing	The drain is fenced on both sides in Location 3123 and between 98 and 88, however stock are allowed seasonal access. Parts of the natural creekline and the drain are fenced on one side, however stock have free access from the opposite bank.
Landform, soils and erosion	Both the drain and the natural creekline continue to flow across the Pinjarra Plain with the main soil types being flat to very gently undulating plains with deep imperfectly or poorly drained acidic yellow, grey or brown gradational earths and mottled yellow duplex soils, with loam to clay loam surface horizons; or poorly drained flats, sometimes with gilgai microrelief and with moderately deep to deep black, olive grey and some yellowish brown cracking clays with generally acidic subsoils. Erosion is a significant problem in this section, with large sections of banks actively eroding and sediment being deposited downstream. This is due to a combination of increased flow rates (through the drain and upstream) due to catchment clearing and installation of drainage networks, the loss of fringing native vegetation and stock access.
Native Vegetation	The northern section of Gynudup Brook in this area supports a healthy overstorey of Flooded Gums (*Eucalyptus rudis*), Paperbarks (*Melaleuca rhaphiophylla*) and Peppermints (*Agonis flexuosa*) with little understorey. There is some regeneration in parts where stock do not have access, for example between the road and rail bridges. There is a healthy patch of *Gahnia trifida* on Railway Rd just west of Elgin Hall.
Weeds	Annual grasses, Kikuyu, Agapanthus, Arum Lily (light), Edible Fig (isolated), African Love Grass, Wavy Gladioli (isolated), *Juncus microcephalus*, *Cyperus congestus*, *Isolepis prolifera*, and Bridal Creeper (in the northern section).
Other comments, special features	One landholder in this section stated Elgin Drain is now five times as wide as when it was constructed. There is a constructed stock crossing in Location 60, however erosion is occurring on either side as the fencing has become degraded and stock are allowed access to all banks. In this section, there is also a revegetation project initiated by the LCDC with a suite of local species. However, as the fences have become degraded, stock have complete access and have grazed and trampled out any understorey.

Issues	Comments
Other comments, special features continued	The mosquito fish (*Gambusia holbrooki*) was found in this area, particularly between the road and railway bridges where sedimentation has created numerous shallow flats dominated by weedy rushes and sedges. These exotic fish are a threat to native fish and frogs. Approximately 15 years ago, the Public Works Dept (now the Water Corporation) constructed a weir with dropgates at the diversion site to allow some flow to enter the natural channel. However, due to poor placement and/or design, this system failed soon after installation. Since then, the bed of the drain has deepened due to erosion and is now approximately 3 metres below the level of the natural creekline.

Map 8: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs.
- Undertake feral animal control. Evidence of large numbers of rabbits was seen in the northern part of this section.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is important to protect what little remaining native vegetation exists. In this case, the riparian vegetation along the old creekline in the northern parts of this section should be protected and enhanced. Planting of a variety of understorey species, including native rushes and sedges, is important.
- Working closely with environmental engineers from DoE, design and install a number of riffles in the stream bed to slow water flow and reduce erosion and sedimentation issues downstream.
- Working with engineers from DoE, design a simple, reliable, low maintenance structure to allow water to be diverted into the natural creekline at the Elgin Drain Diversion to improve environmental flows in this northern section of Gynudup Brook.



Gynudup Brook & Tren Creek Map 8

Map 9

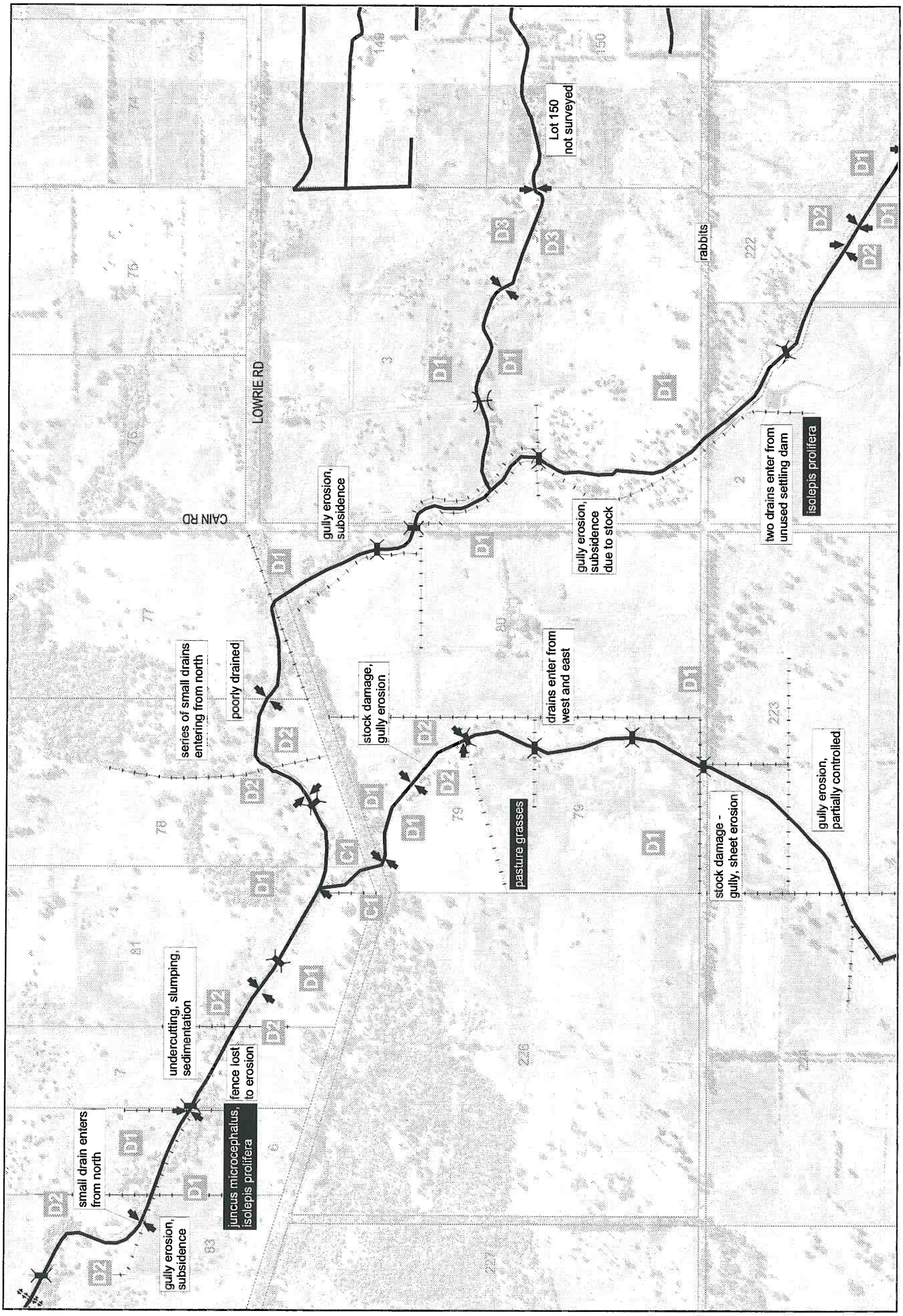
This map shows two branches of Gynudup Brook flowing approximately northwards, before joining and flowing north westerly. The western branch carries low flows and passes through a variety of agricultural land. The eastern of the two branches carries significantly more flow, and is boosted by a small swale type drain entering from the east in Location 3.

Land use in the area includes beef grazing and dairying.

Issues	Comments
Fencing	Parts of this section of creek are fenced, however only on one side, and stock have access to both banks. In one section of Location 3 there is fencing on both sides of the waterway, however it appeared to be temporary and stock had access to the bank. A fence on Location 7 has been lost due to bank subsidence, and a replacement fence has been constructed without addressing the underlying cause.
Landform, soils and erosion	Both branches of Gynudup Brook continue to flow across the Pinjarra Plain in this section, with the main soil types being shallow to moderately deep pale sand to sandy loam over clay that is imperfectly or poorly drained, and broad poorly drained flats of moderately deep to deep sands over mottled clays. Erosion is a significant issue in this section, with numerous areas in the eastern and northern sections showing bank instability.
Native Vegetation	Apart from isolated Flooded Gums (*Eucalyptus rudis*) and Paperbark (*Melaleuca rhaphiophylla*) along the stream channels, there are few patches of healthy native remnant vegetation. The road reserve to the west of Lowrie Rd contains some healthy Marri, Jarrah and Flooded Gum overstorey with a fairly diverse understorey, however it has been affected by grazing and trampling by stock. There is also a healthy patch of Banksia dominated vegetation in the westernmost part of this map.
Weeds	Kikuyu, annual grasses, Dock, Pennyroyal, *Isolepis prolifera*, *Juncus microcephalus*, Wavy Gladioli (isolated), Freesia (light) and Bridal Creeper (one small patch in Location 81).
Other comments, special features	Location 150 was not assessed. Repeated attempts to get in contact with the landholder failed. From the property boundaries, the waterway appeared as in Location 3, a small grassed swale drain with low flow and no significant erosion problems. Weeds likely to be found include annual grasses, Kikuyu and Dock. The mosquito fish (*Gambusia holbrooki*) was found in large numbers in areas of still or low flow water in the area near Lowrie Rd. These exotic fish are a threat to native fish and frogs.

Map 9: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs.
- Undertake feral animal control. Evidence of large numbers of rabbits was seen in the southern and western parts of this area.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is important to protect what little remaining native vegetation exists. Planting a variety of understorey species, including native rushes and sedges, is important.
- A number of landholders in this area have been planting a variety of species (primarily Bluegums *E. globulus*) as wind and shelter belts or for aesthetic purposes. In future, local species should be used, and where possible an understorey should be established Detailed information on windbreaks is available in the *Geographe Catchment Companion* (GeoCatch, 2004).



Gynudup Brook & Tren Creek Map 9

Map 10

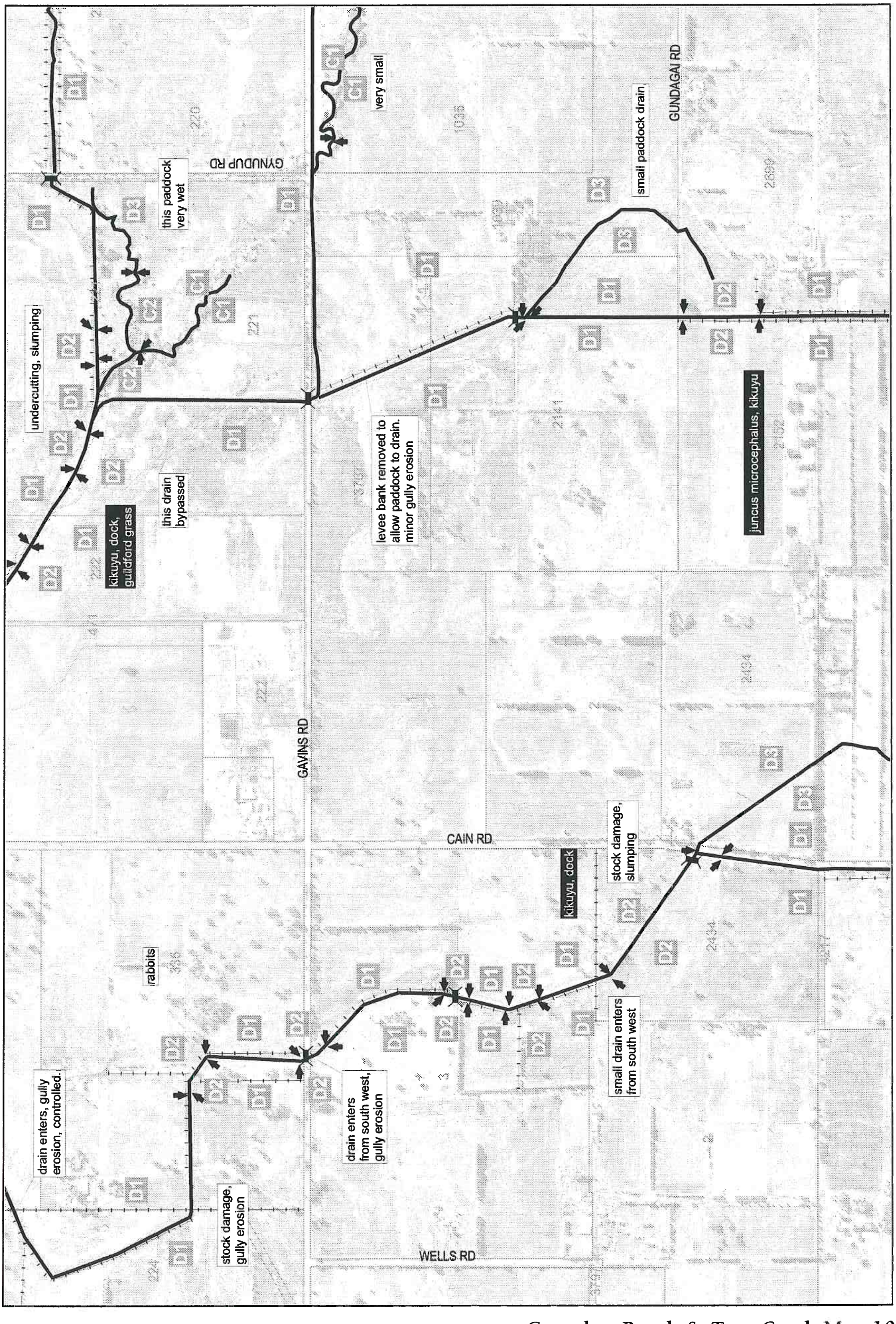
There are a number of natural and artificial branches of Gynudup Brook in this section. The western branch continues north along Cain Rd briefly before flowing north west across agricultural land as a straightened drain. This branch has relatively little flow. In the south east corner of the map, the drain continues due north before winding north west briefly, then north again before meeting another agricultural drain that is running westerly. Also coming in from the east, is a newly constructed drain that runs parallel to Gavins Rd before joining the aforementioned drain running north. These drains carry the majority of the flow in this section. There is also the remains of the old creekline near Gavins Rd; flow to this creekline has now been bypassed to the roadside drain, with very little flow south of Gavins Rd. This creek in Location 221 north of Gavins Rd picks up water from the paddock and has some flow by the time it discharges into the agricultural drain. Previously, there was a constructed drain running north west from Gavins Rd to the main agricultural drain running west this has now been bypassed and carries little, if any flow.

Land use in the area includes beef grazing, dairying and, in previously, an abattoir (Location 222).

Issues	Comments
Fencing	Parts of the various branches of Gynudup Brook are either partially or not fenced in this section. Where there is fencing on one bank, stock generally have access from the other side.
Landform, soils and erosion	These branches of Gynudup Brook flow across the Pinjarra Plain in this section, with the main soil type being shallow to moderately deep pale sand to sandy loam over clay that is imperfectly or poorly drained. Erosion is a significant issue on this section, with numerous areas in the eastern sections showing bank instability.
Native Vegetation	Apart from a small patch of remnant Paperbark (*Melaleuca rhaphiophylla*) and Flooded Gum (*Eucalyptus rudis*) in Location 221, there is very little native vegetation remaining. Isolated paddock trees of Marri, Jarrah, Flooded Gum and Paperbark exist, but no regeneration is present.
Weeds	Annual grasses, Kikuyu, African Love Grass, Dock, *Juncus microcephalus*, *Isolepis prolifera*.
Other comments, special features	

Map 10: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs.
- Although few feral animals were seen in this section, it is important to be vigilant and undertake control when necessary.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is important to protect what little remaining native vegetation exists. In this case, the riparian vegetation along the old creekline in Location 221 should be protected and enhanced. Planting a variety of understorey species, including native rushes and sedges, is important.
- A number of landholders in this area have been planting a variety of species (primarily Bluegums *E. globulus*) as wind and shelter belts or for aesthetic purposes. In future, local species should be used, and where possible an understorey should be established. Detailed information on windbreaks is available in the *Geographe Catchment Companion* (GeoCatch, 2004).



Gynudup Brook & Tren Creek Map 10

Map 11

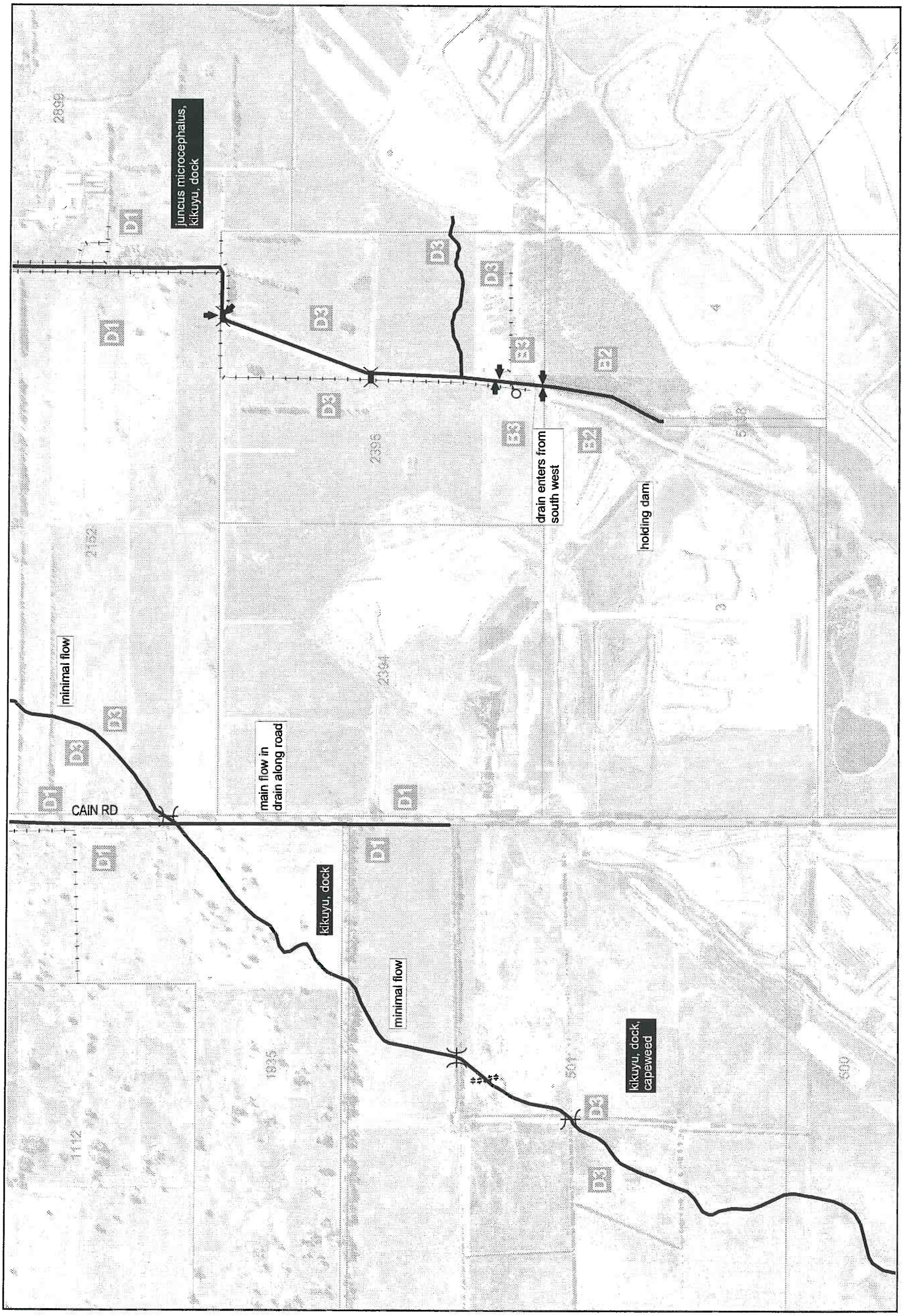
There are two small branches of Gynudup Brook in this section, both running in an approximately northerly direction. The eastern branch now begins as part of a licensed discharge point for a mineral sands extraction operation. It follows a course that was previously a natural creekline, but has been straightened and de-snagged over time so that it now resembles a common agricultural drain. The licensed discharge provides year round flow, albeit small in summer. The western branch begins as a small grassed (mainly dry) depression across paddocks, gradually getting larger and collecting water from adjacent paddocks. Where it reaches Cain Rd, it is intercepted and all flow continues in an open drain running parallel to the road and property boundary.

Main land use in the area includes mineral sands extraction, beef grazing, and dairying.

Issues	Comments
Fencing	Only one part of the western branch is fenced, in Location 1935, however it appears that stock are allowed access to this bank at times. In the eastern branch, parts of Location 2395 and 2899 are fenced; stock are allowed access from the opposite bank. The northernmost section of 2899 is fenced on both sides, however stock are allowed access at certain times.
Landform, soils and erosion	Both branches of Gynudup Brook flow across the Pinjarra Plain in this section, with the main soil type being moderately deep pale sand to sandy loam over clay that is imperfectly drained. Banks in this section are generally quite stable, however the northern sections of both branches show subsidence and slumping due to stock damage.
Native Vegetation	Small section of very healthy vegetation in Drainage Reserve 5138. Apart from this small strip, there is no native riparian vegetation.
Weeds	Kikuyu, annual grasses, Dock, Guildford Grass, Capeweed, Mallow.
Other comments, special features	Some filamentous algae was noticed growing in the channel on Location 2395. This may be an indicator of excessive nutrients, however the lack of fringing vegetation and relatively low flow in this section provide good conditions for algal growth, and nutrient levels may not be excessively high.

Map 11: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. It is particularly important to focus on the small patch of healthy vegetation in the drainage reserve and Location 4. Although the stream is not fenced, it is not grazed at present and it is unlikely that it will be in the future. Assisting the natural regeneration that is occurring in this area is very important as it is the only remnant riparian vegetation in this section. Ensuring that weed invasion does not become an issue in this area is essential.
- Work closely with Iluka Resources Pty Ltd to share information and data on water quality.



Gynudup Brook & Tren Creek Map 11

Map 12

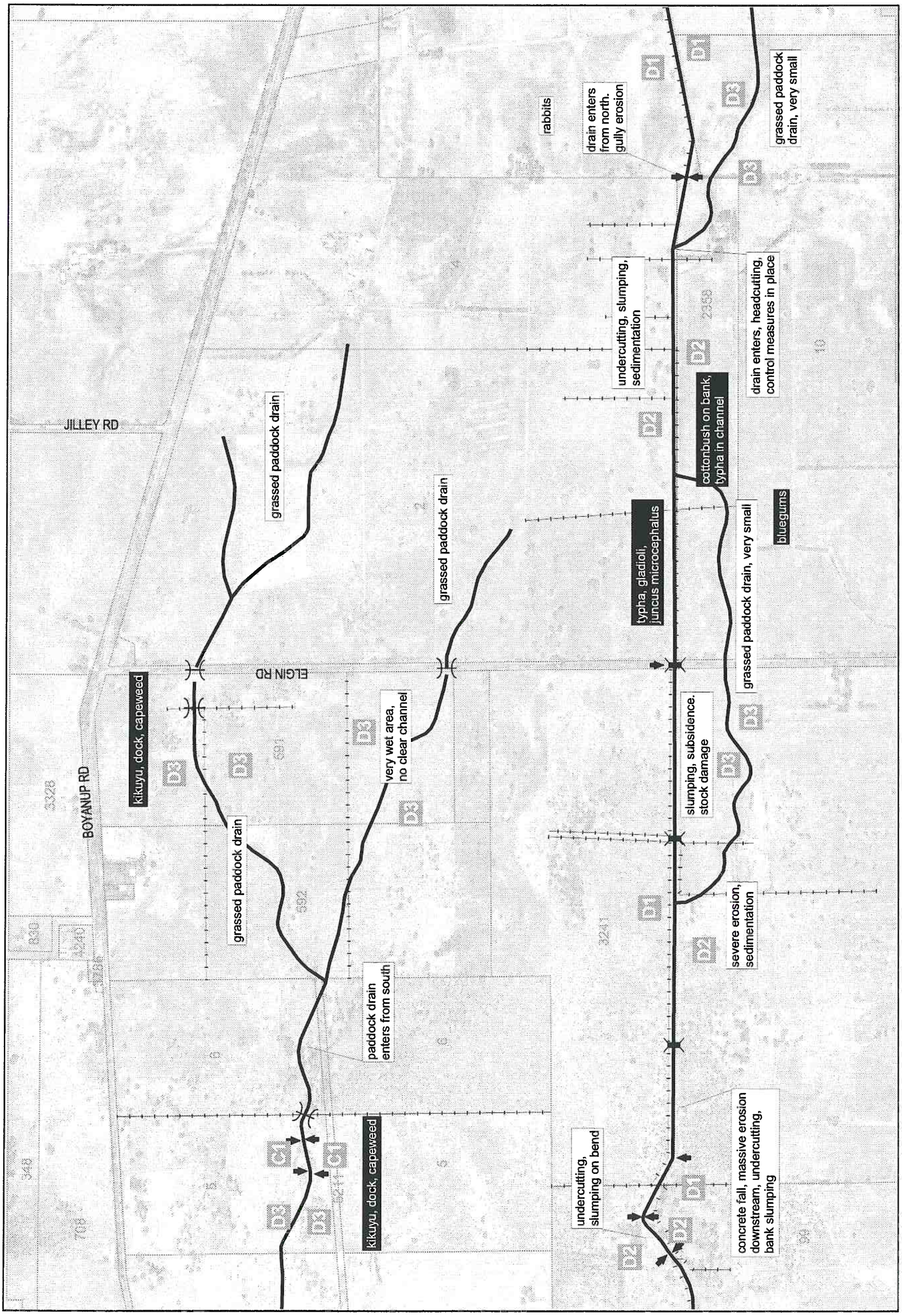
In this map, there are two main sections of Gynudup Brook. The northern branch consists primarily of a small shallow grassed drain running approximately west. The southern section is a large straight, deep, steep sided agricultural drain that was constructed in approximately 1970. Adjacent to this is the remnant of the old creekline. In parts this was filled in with spoil removed from the construction of the drain. Elsewhere, it is a small, grassed system that drains adjacent paddocks.

Land use in the area includes beef grazing and dairying.

Issues	Comments
Fencing	The majority of the southern branch is fenced in this section but only on one side and stock have access to both banks. There is no fencing on the northern branch.
Landform, soils and erosion	Both branches flow across the Pinjarra Plain, and in this area the main soil types are shallow pale sand or sandy loam over clays that are poorly drained, or a very shallow grey sand over deep, cracking alkaline clays. Erosion is a significant problem in this section, primarily in the southern branch where the drain is freely eroding in parts. Bank undercutting and slumping is common in this area, particularly on Locations 3241 and the boundary between 2358 and Locations 2 and 4.
Native Vegetation	There is no native riparian vegetation in this area apart from isolated Flooded Gums (*Eucalyptus rudis*) and Paperbarks (*Melaleuca rhaphiophylla*) in the southern branch. The northern branch supports isolated patches of Marri and Flooded Gums.
Weeds	Annual grasses, Kikuyu, Guildford Grass, Capeweed and Narrow Leaf Cotton Bush, *Juncus microcephalus*, *Isolepis prolifera*, *Typha orientalis*.
Other comments, special features	Where the old creekline enters the main drain on Location 2358, significant headcutting has been reduced by the placement of a rock toe constructed by the landholder. A native aquatic water lily (*Ottelia ovalifera*) was found in this section, but nowhere else in t he catchment. Propagation of this species and its use as a submergent revegetation species could be useful.

Map 12: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs.
- Undertake feral animal control, particularly of rabbit, as evidence of large numbers was seen in the area and they can destabilise banks and hinder regeneration of native vegetation.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information.
- Working closely with environmental engineers from DoE, design and install a number of riffles in the stream bed of the lower branch to slow water flow and reduce erosion and sedimentation downstream.
- A number of landholders in this area have been planting a variety of species (primarily Bluegums *E. globulus*) as windbreaks and shelter belts. In future plantings, local species should be used, and where possible an understorey should be created. Detailed information on windbreaks is available in the *Geographe Catchment Companion* (GeoCatch, 2004).



Gynudup Brook & Tren Creek Map 12

Map 13

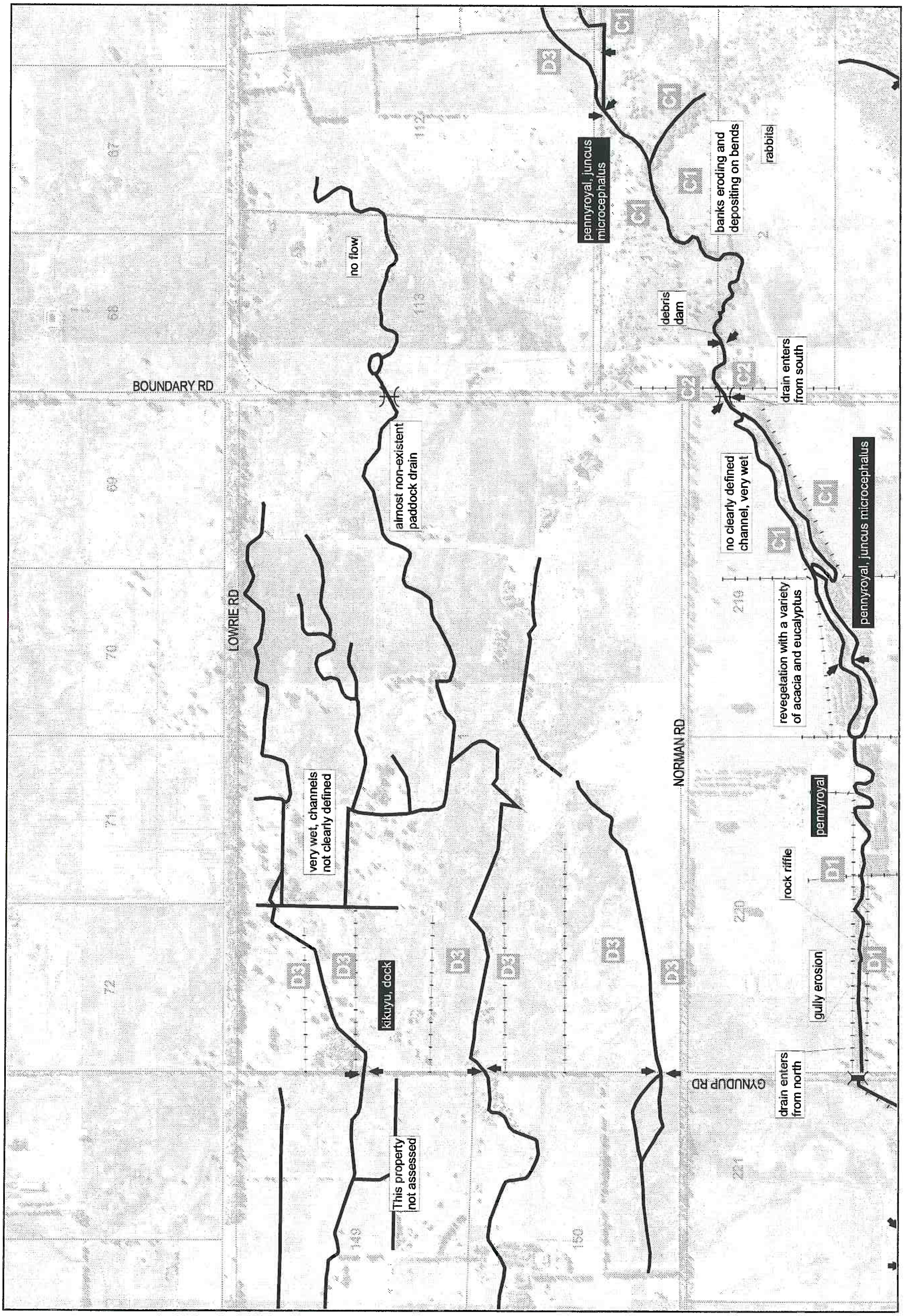
There are two small branches of Gynudup Brook in this section. The northern branch consists of poorly defined grassed runs (mainly dry) in the eastern section, before flowing in a series of small channels (some deepened/formed by landholders). This area is very poorly drained and seasonally inundated. The southern branch starts as a poorly defined channel in a poorly drained agricultural paddock, flowing south west and gradually forming a narrow, shallowly incised channel. After crossing Boundary Rd, it widens and shallows, forming a series of pools with very little flow. At the boundary of Locations 219 and 220, it is formed into two pipes under a gravel track. From there, it follows a meandering incised stream channel for approximately 300 metres, before becoming a straight, steep sided agricultural drain.

The main land use in the area is beef grazing.

Issues	Comments
Fencing	Part of Location 220 is fenced on both sides, while Locations 219 and 220 are partially fenced but allow stock access from the opposite bank.
Landform, soils and erosion	Both branches flow across the Pinjarra Plain, with most of the soil in this area being sand or sandy loam over clay, generally poorly or imperfectly drained. Erosion is not a significant issue in this area, however there are isolated patches of bank undercutting and slumping due to loss of native vegetation and stock damage in the south east corner of the map.
Native Vegetation	Flooded Gum (*Eucalyptus rudis*) and Paperbark (*Melaleuca rhaphiophylla*) with a limited understorey of Juncus pallidus and J. amabilis on Locations 1 and 2. Elsewhere, vegetation has been cleared or replaced by exotic species.
Weeds	Kikuyu, annual grasses, Dock, Pennyroyal, *Juncus microcephalus*. Bridal Creeper (*Asparagus asparagoides*) was noted along roadsides in this area.
Other comments, special features	Location 149 was not assessed. Repeated attempts to get in contact with the landholder failed. From the property boundary, the creek appeared as in Location 1, that is a small grassed swale drain with low flow and no significant erosion problems. Weeds likely to be found include annual grasses, Kikuyu and Dock. Locations 219 and 220 have had significant revegetation projects, with a variety of species planted. The majority of these have been trees, primarily Eucalypts and Acacias, with many non-local species including some weedy species such as tagasaste (*Chamaecytisus palmensis*).

Map 13: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Continue and expand weed control programs.
- Undertake feral animal control.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. Priority areas in this section include Locations 1 and 2 in the south east corner of the map, where some relatively healthy remnant vegetation remains. Planting a variety of understorey species, including rushes and sedges, would be beneficial.
- Future plantings for windbreaks or aesthetic purposes should comprise local native species, with a diverse understorey including rushes and sedges. This is especially important along creeks and drains. Detailed information on windbreaks is available in the *Geographe Catchment Companion* (GeoCatch, 2004).



Gynudup Brook & Tren Creek Map 13

Map 14

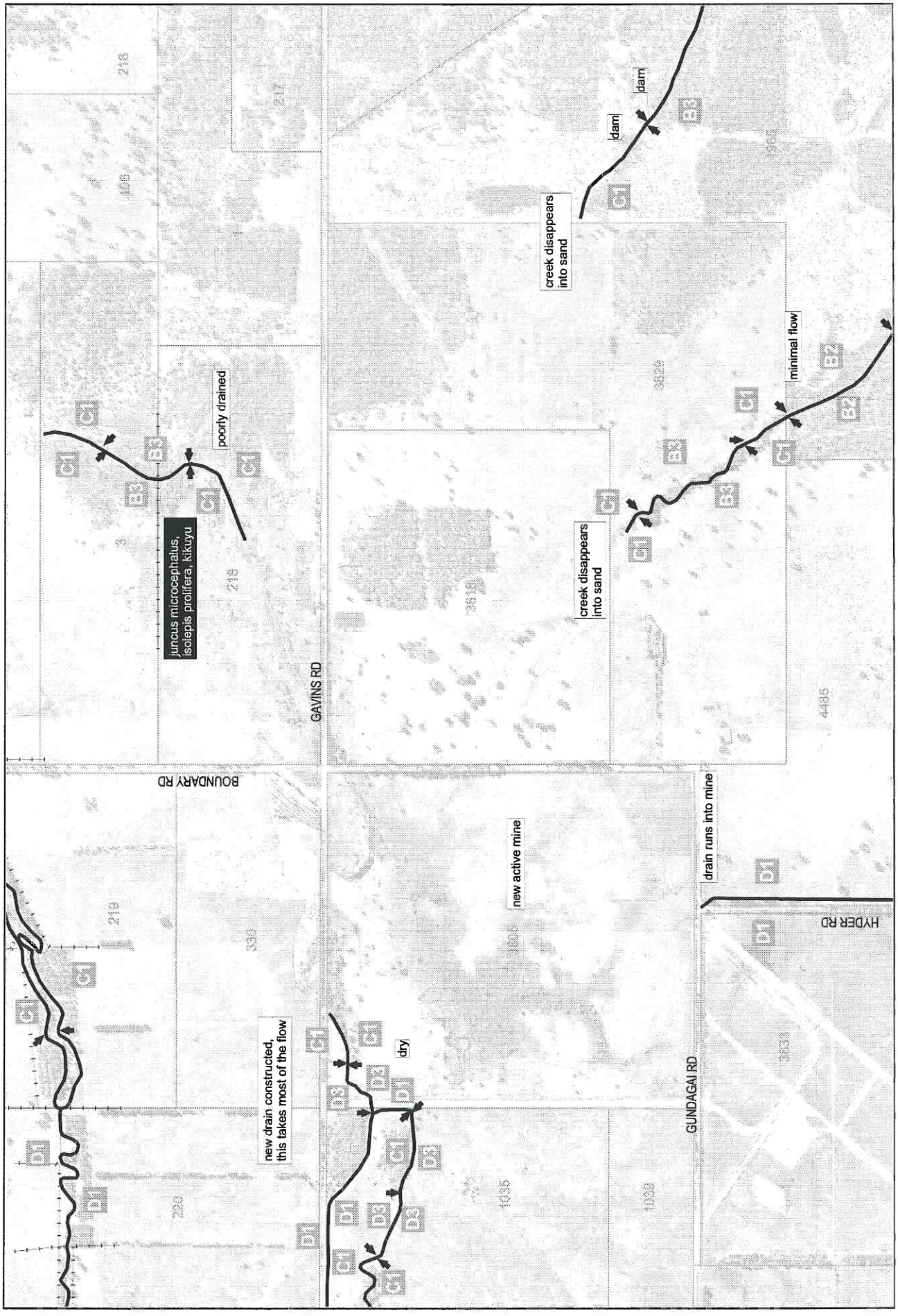
There are two small branches of Gynudup Brook in this section. The northern branch flows in a south westerly direction from an area of very wet, seasonally inundated land with no clearly defined channel, across agricultural land in a narrow channel. It then diverts around an active mine site and eventually flows directly west along a newly constructed drain parallel to Gavins Road. The southern branch leaves a healthy and dense patch of remnant vegetation on private land before disappearing into deep sand. There is also a drain in the south that runs parallel to the southernmost section of Gundagai Rd, before flowing into the mine site.

Land use in this area includes dairying, grazing, tree cropping and mineral sands extraction.

Issues	Comments
Fencing	None of these sections of creek were fenced, with grazing occurring in all locations except the active mine site.
Landform, soils and erosion	Both branches flow across the Forrestfield System, where the soils are generally deeply bleached and very rapidly draining, although poorly drained bleached sands occur in parts. Banks are generally stable, although the banks of the new drain parallel to Gavins Rd in Location 1035 are eroding due to stock damage and lack of vegetation.
Native Vegetation	The southern branch contains very healthy remnant vegetation, primarily a Jarrah, Marri and Mountain Marri open forest with a diverse understorey including Banksia, Woody Pear and Stirlingia. The western-most section of the middle has an overstorey of *Melaleuca rhaphiophylla*, but no understorey apart from grassy weeds, while the northern branch has quite healthy *M. rhaphiophylla*, *Taxandria linearifolia*, *Astartea fascicularis* and a variety of native rushes and sedges such as *Juncus pallidus*, *J. kraussii* and *J. amabilis*.
Weeds	Kikuyu, annual grasses, Dock, *Juncus microcephalus*, *Isolepis prolifera*.
Other comments, special features	Large numbers of mosquito fish (*Gambusia holbrooki*) were found in Location 218. These exotic fish are a threat to native fish and frogs. The area around Gundagai (which has since been realigned) and Gavins Rd, (part of which is currently being mined), is a seasonally very wet area where a number of creeks that have disappeared into sand upstream (to the east) are thought to resurface. The mining company involved (Iluka Resources Pty Ltd) has reported large amounts of sub-surface water transport in the area. Location 3829 is proposed to be the site of a new mineral sands mine (Cable Sands Pty Ltd) which is awaiting approval. The creek itself would not be mined, and a buffer of 20 metres of each side would be left.

Map 14: Management recommendations and advice

- Continue to fence off the creek to restrict stock access where grazing occurs. This is very important on Location 1035 as the new drain is unstable and there is very little vegetation supporting the banks. This could be a trial site for the use of perennial grasses to reduce erosion. Restriction of stock access to the creek on Locations 218 and 3 would greatly assist the natural regeneration that is occurring.
- Construct stable stock crossings or bridges.
- Provide stock water away from creek to minimise damage and protect water quality.
- Undertake feral animal control. Quite a few foxes and rabbits were seen in the northern section.
- Continue and expand weed control programs.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. Priority areas would include Location 3829, where a 20 metre buffer zone would be placed around the creek from a new mine that is proposed. Working with Cable Sands Pty Ltd, it is recommended that the buffer zone be increased to at least 30 m, preferably 50 m on each side, fenced and revegetated with local native species. The existing vegetation on this location and 4965 provides an excellent starting point to work out from. If the creek is protected from grazing and weed control is undertaken, it is likely that natural regeneration would occur. Planting a wide variety of local native species in a buffer around this creek would assist the natural regeneration.



Gynudup Brook & Tren Creek Map 14

Map 15

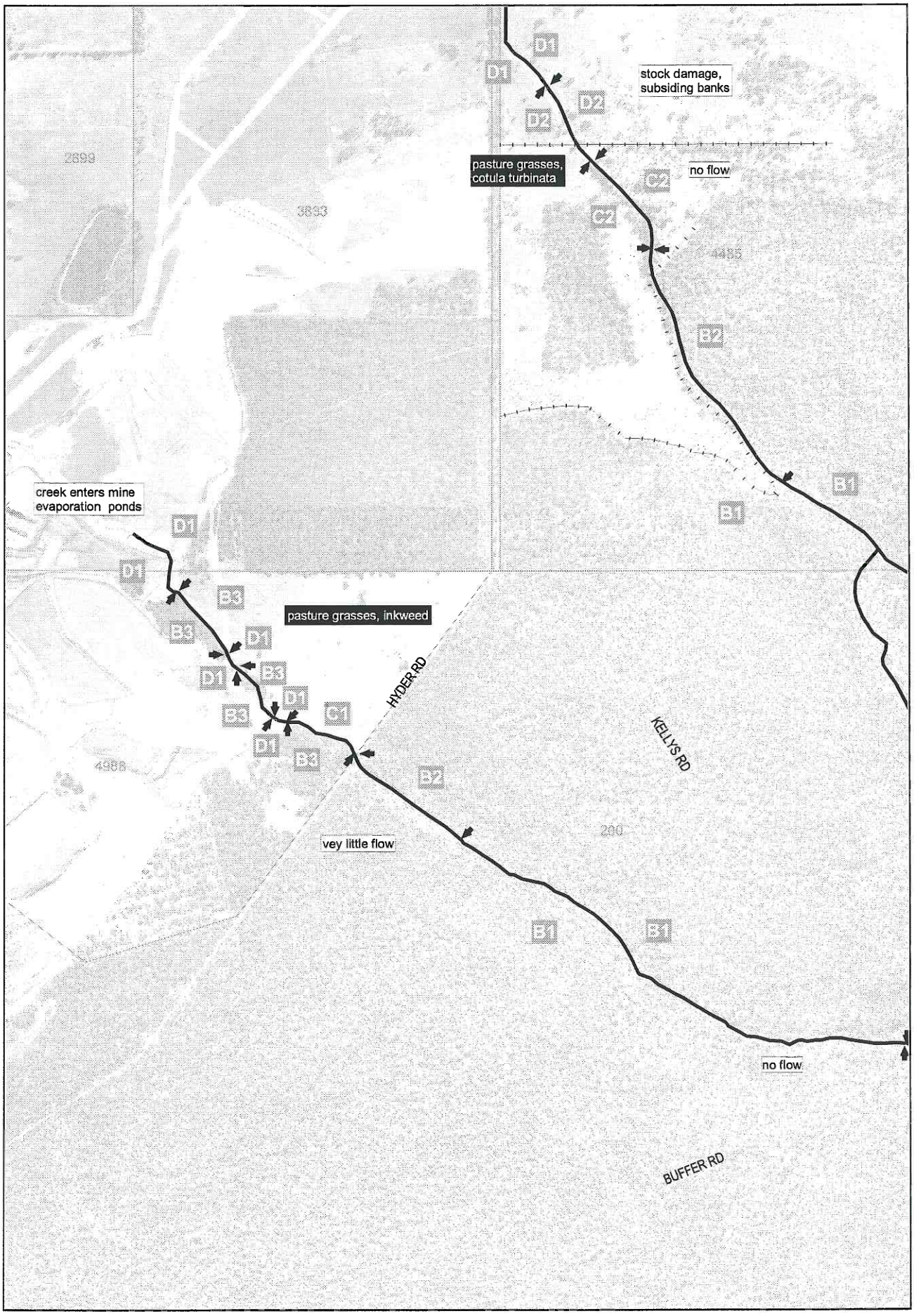
Map 15 shows two small branches of Gynudup Brook flowing in a north westerly direction. The lower branch flows through State Forest into a small stretch of agricultural land, before entering an evaporation pond that is part of a mineral sands extraction operation. The northern branch flows from State Forest across some agricultural land before meeting a roadside drain in the far north of the map. There are very minimal flows in both branches in this area.

Land use includes grazing and mineral sands extraction.

Issues	Comments
Fencing	Only a small part of Location 4485 is fenced. Grazing occurs in Locations 4485 and in parts of 4988.
Landform, soils and erosion	Both branches flow from the Whicher Scarp into the Forrestfield System, where the soils are generally deeply bleached and very rapidly draining, although in parts poorly drained bleached sands occur. Banks are generally stable, although parts of 4485 are collapsing due to stock damage.
Native Vegetation	The State Forest is very healthy, comprising an open woodland of Jarrah, Marri and Mountain Marri with a very diverse understorey. This vegetation community continues onto private land, although generally only as a narrow band.
Weeds	Annual grasses, Kikuyu, Inkweed, *Cotula turbinata* and Capeweed.
Other comments, special features	

Map 15: Management recommendations and advice

- Continue to fence off the creek to restrict stock access. This is especially important in this section as the remaining vegetation is in very good condition compared to the rest of the catchment.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise damage and protect water quality.
- Undertake feral animal control.
- Continue and expand weed control programs.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information. Priority areas in this section are Locations 4988 and 4485, where there is already a good base to work out from. Widening of the riparian zone and enhancing the natural regeneration that is occurring on the degraded sections of 4485 would be very beneficial.
- In consultation with DCLM, undertake a more comprehensive vegetation survey of the State Forest.



Gynudup Brook & Tren Creek Map 15

Map 16

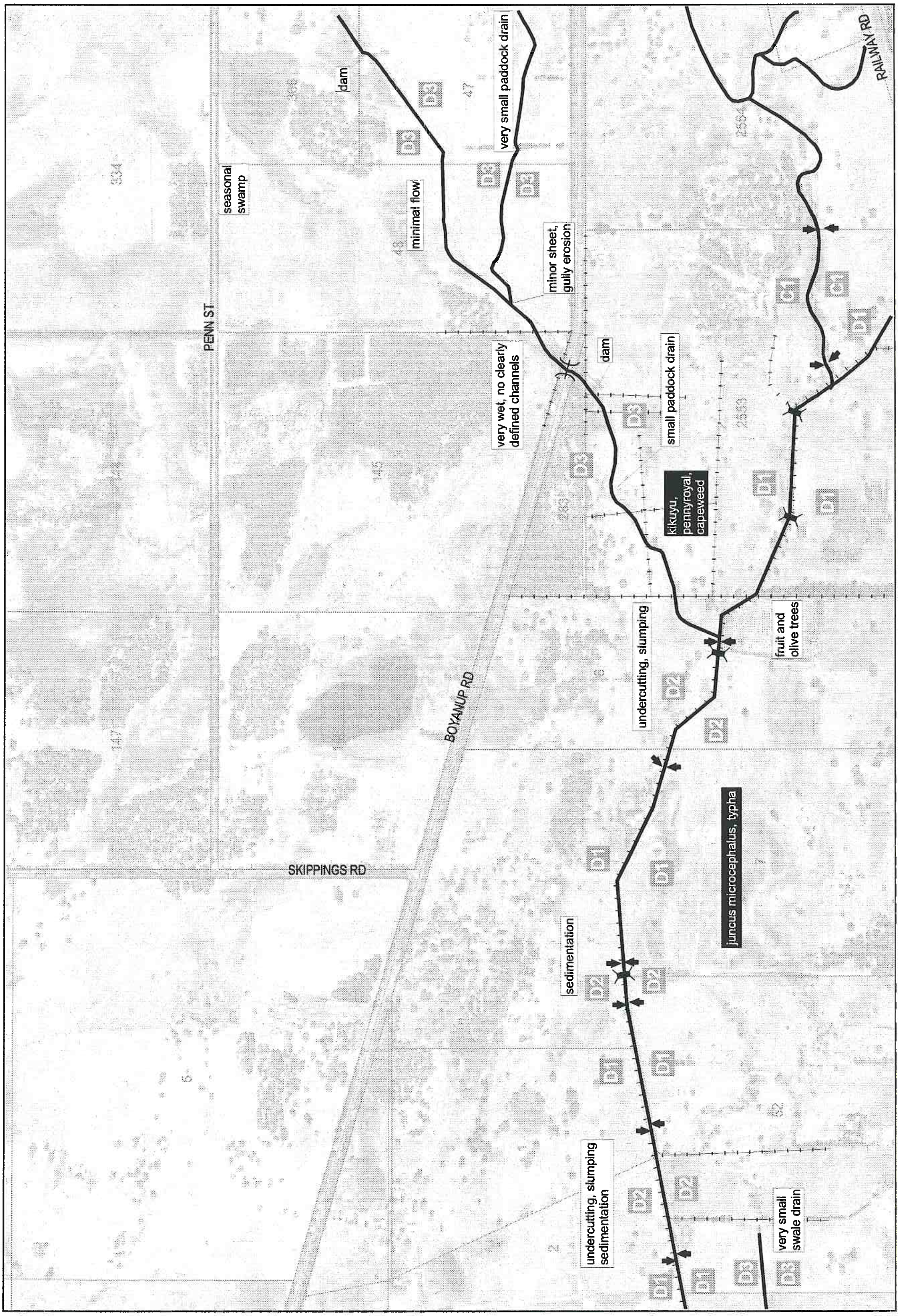
This shows Gynudup Brook flowing approximately south west before it reaches an agricultural drain that intercepts all flow and continues in a westerly direction. The drain was constructed in approximately 1970 and extends east past where Gynudup Brook enters. Upstream of Boyanup Rd there is little flow initially, and it slowly picks up flow from adjacent paddocks until it enters the drain.

Land use in the areas include grazing, dairying and horticulture (stone fruit and olives).

Issues	Comments
Fencing	Locations 366, 47, 48, 145, 283 and 2553 are unfenced. Locations 6 and 52 are partially fenced with stock allowed access to water. Locations 1, 2 and 7 are fenced on both sides of the brook, however, stock are allowed access at times. The drain running south east through 2553 is partially fenced, however stock have access from the other bank.
Landform, soils and erosion	This section of Gynudup Brook flows across the Pinjarra Plain, with most of the soil in this area being sand or sandy loam over clay, generally poorly or imperfectly drained. Erosion is an issue in this area, downstream of where the drain meets Gynudup Brook.
Native Vegetation	Very little native vegetation remains in this section, with isolated Flooded Gums and Paperbarks (*Melaleuca rhaphiophylla*) occurring as paddock trees or along the drain, and patches of remnant Marri and Peppermint elsewhere.
Weeds	Couch, Kikuyu, Pennyroyal, Dock, Capeweed, Guildford Grass, Typha, Apple of Sodom, African Love Grass.
Other comments, special features	The natural creekline in Location 52 does not exist any more as it was filled in with spoil removed from the drain when constructed. Some landholders were concerned that the drain has got much larger since it was constructed (due to erosion), and that it now takes too much water away too quickly.

Map 16: Management recommendations and advice

- Continue to fence off creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from creek to minimise damage and protect water quality.
- Continue and expand weed control programs.
- Numerous rabbits were seen in this area. Large numbers of warrens can destabilise banks and exacerbate erosion. Undertake feral animal control.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information.
- Future plantings for windbreaks or aesthetic purposes should comprise native species, with a diverse understorey, including rushes and sedges. This is especially important along creeks and drains. Detailed information on windbreaks is available in the *Geographe Catchment Companion* (GeoCatch, 2004).



Gynudup Brook & Tren Creek Map 16

Map 17

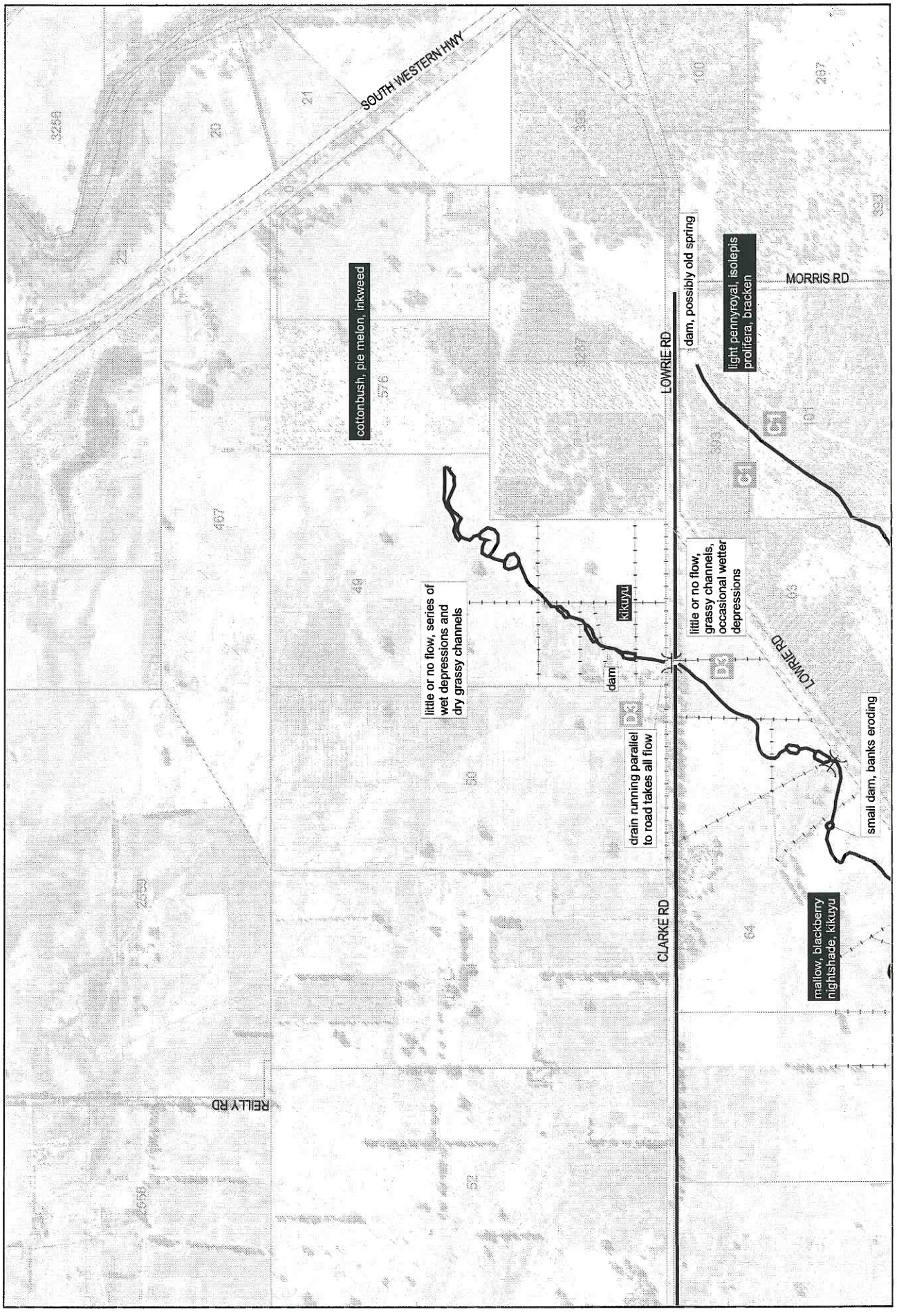
There are two small branches of Gynudup Brook in this section of the catchment. The northern branch exits as a series of seasonal pools and dry grassed reaches across agricultural land. The southern branch is a straightened drain running through a Bluegum plantation. It starts at a small dam that has resulted from a natural spring being dug out.

Land use in the area includes beef grazing, horticulture and tree cropping.

Issues	Comments
Fencing	No part of these branches is fenced and grazing occurs on all locations, although only lightly in Locations 63, 101 and 393.
Landform, soils and erosion	Both branches flow across the Pinjarra Plain, with most of the soil in this area being sand or sandy loam over clay, generally poorly or imperfectly drained with poorly defined stream channels. Erosion is not a major concern in this area.
Native Vegetation	Apart from regeneration of native rushes (primarily *Juncus pallidus*) and Tea Tree (*Astartea fascicularis* and *Taxandria linearifolia*) in parts of the Bluegum plantation, no native vegetation exists in this section.
Weeds	Kikuyu, annual grasses, Capeweed, Mallow, *Juncus microcephalus*, and *Isolepis prolifera*.
Other comments, special features	A drain runs parallel to Clarke Rd and takes the majority of all flow in this section. It intercepts all flow coming from Location 49 and also most of the flow that occurs as a result of the natural up-welling in Location 393. Bracken although a native species, is becoming quite dense in Locations 101 and 393 and may need to be controlled.

Map 17: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Undertake feral animal control.
- Continue and expand weed control programs, especially in the tree farm just east of Location 49. A number of declared and other species, such as Narrow Leaf Cotton Bush, Pie Melons, Inkweed and a variety of Brassica species are growing here and they have the potential to adversely impact upon the Gynudup Brook downstream.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information.



Gynudup Brook & Tren Creek Map 17

Map 18

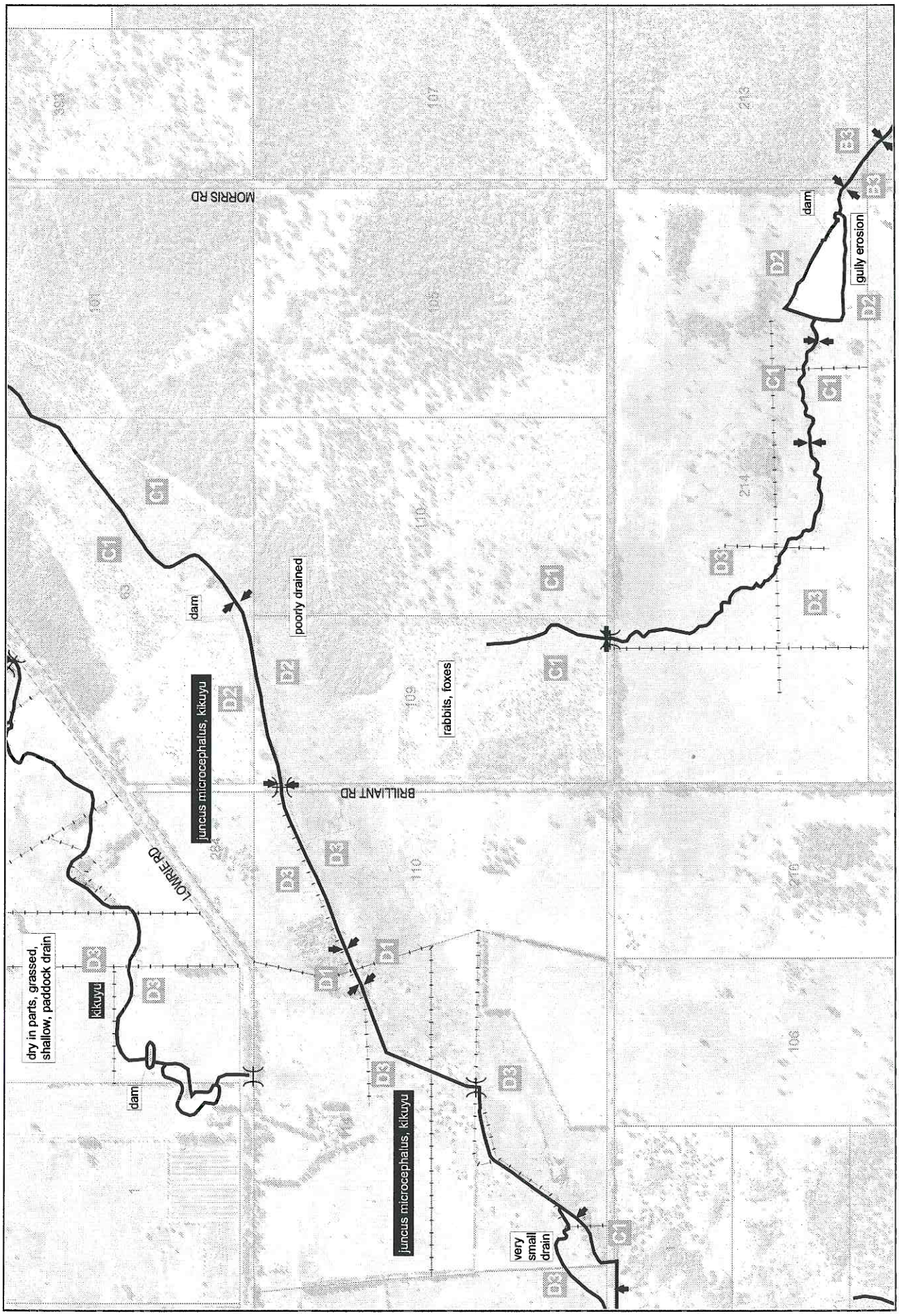
The southernmost branch of Gynudup Brook in this section leaves State Forest and flows into farmland, before disappearing into deep sands. This branch has minimal flows. The middle branch continues through a Bluegum plantation as a straightened drain before entering farmland and meandering in a south westerly direction. The northern branch exists as a series of dry grassed reaches and small seasonal pools.

Land use in the area includes beef grazing, horticulture, tree cropping and poultry farming.

Issues	Comments
Fencing	Only part of Locations 111 and 114 is fenced, with grazing occurring on all sections of the creek.
Landform, soils and erosion	The southern branch flows from the Forrestfield System and onto the Pinjarra Plain. The middle and northern branches also flow across the Pinjarra Plain, with most of the soil in this area being sand or sandy loam over clay, generally poorly or imperfectly drained with poorly defined stream channels. Erosion is not a major concern in this area.
Native Vegetation	Apart from a small section of the southern branch flowing through State Forest, most of the native vegetation has been cleared. There are isolated Paperbarks (*Melaleuca rhaphiophylla*) and Flooded Gums (*Eucalyptus rudis*) in parts and native rushes and sedges are quite dense in parts of the Bluegum plantation. There is a small patch of regenerating Tea Tree (*Taxandria linearifolia* and *Astartea fasicularis*) on Location 214 just downstream of dam.
Weeds	Kikuyu, Capeweed, *Juncus microcephalus*, *Isolepis prolifera*, Pennyroyal.
Other comments, special features	The large dam on Location 214 was only recently built. It has not yet reached capacity, however considerable seepage through the walls allows winter flow across Location 214 and part of 109 before it disappears into deep sand.

Map 18: Management recommendations and advice

- Continue to fence off the creek to restrict stock access.
- Construct stable stock crossings or bridges.
- Provide stock water away from the creek to minimise bank damage and protect water quality.
- Undertake feral animal control, as large numbers of foxes and rabbits were seen in the area.
- Continue and expand weed control programs.
- Assist regeneration of native vegetation and expand the riparian zone through planting of local native species. Appendix 1 contains a list of local species suitable for planting. See Chapter 5 for detailed techniques and information.



Gynudup Brook & Tren Creek Map 18

Map 19

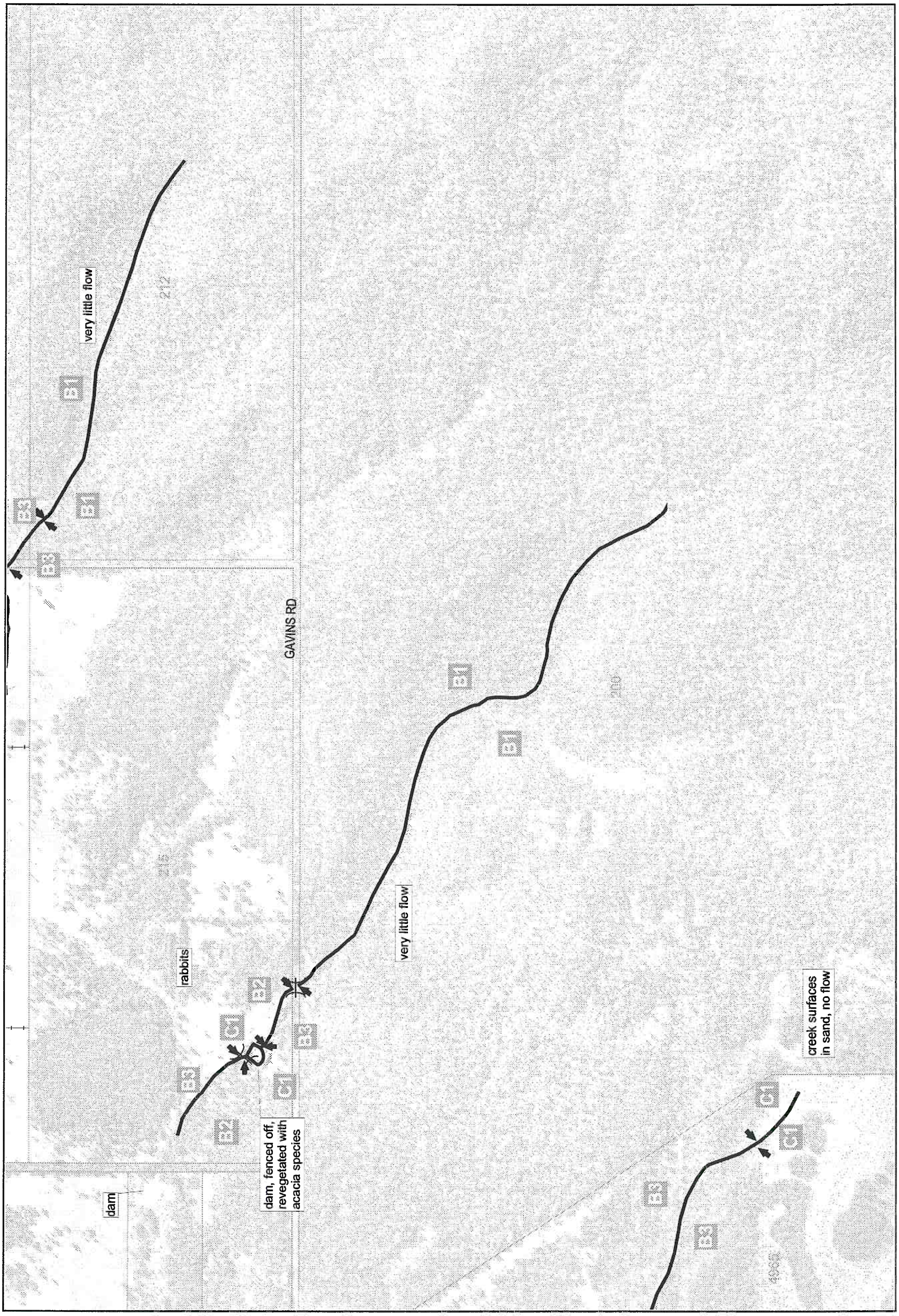
Two small tributaries of Gynudup Brook begin in State Forest, while a third forms on private property. There are very minimal flows of all these creeks, with the middle creek disappearing into sand.

Land use in the area includes tree cropping, beef grazing and State Forest.

Issues	Comments
Fencing	No part of these creeks is fenced. Lot 215 is grazed lightly at various times throughout the year.
Landform, soils and erosion	The creeks come off the Whicher Scarp and enter the Forrestfield System. Soils here are generally deeply bleached, very rapidly draining sands, although in parts poorly drained bleached sands occur. Banks are generally stable, although vulnerable to incision. No major erosion apparent.
Native Vegetation	State Forest 27 is an open forest of Jarrah and Marri, with a diverse understorey including Banksia, Woody Pear and Stirlingia.
Weeds	Minimal weeds in this section. Annual grasses, Capeweed and Inkweed were most common.
Other comments, special features	Protection of the remnant vegetation in this section is very important as it is one of the few remnants of riparian vegetation in the catchment.

Map 19: Management recommendations and advice

- Fence the creekline in Location 215 to prevent stock access.
- Undertake feral animal control, especially of rabbits, as they can be a significant cause of bushland degradation.
- Ensure continued protection of State Forest and the high quality vegetation in Location 215.
- In consultation with DCLM, undertake a comprehensive vegetation survey of State Forest 27.



Gynudup Brook & Tren Creek Map 19

Map 20

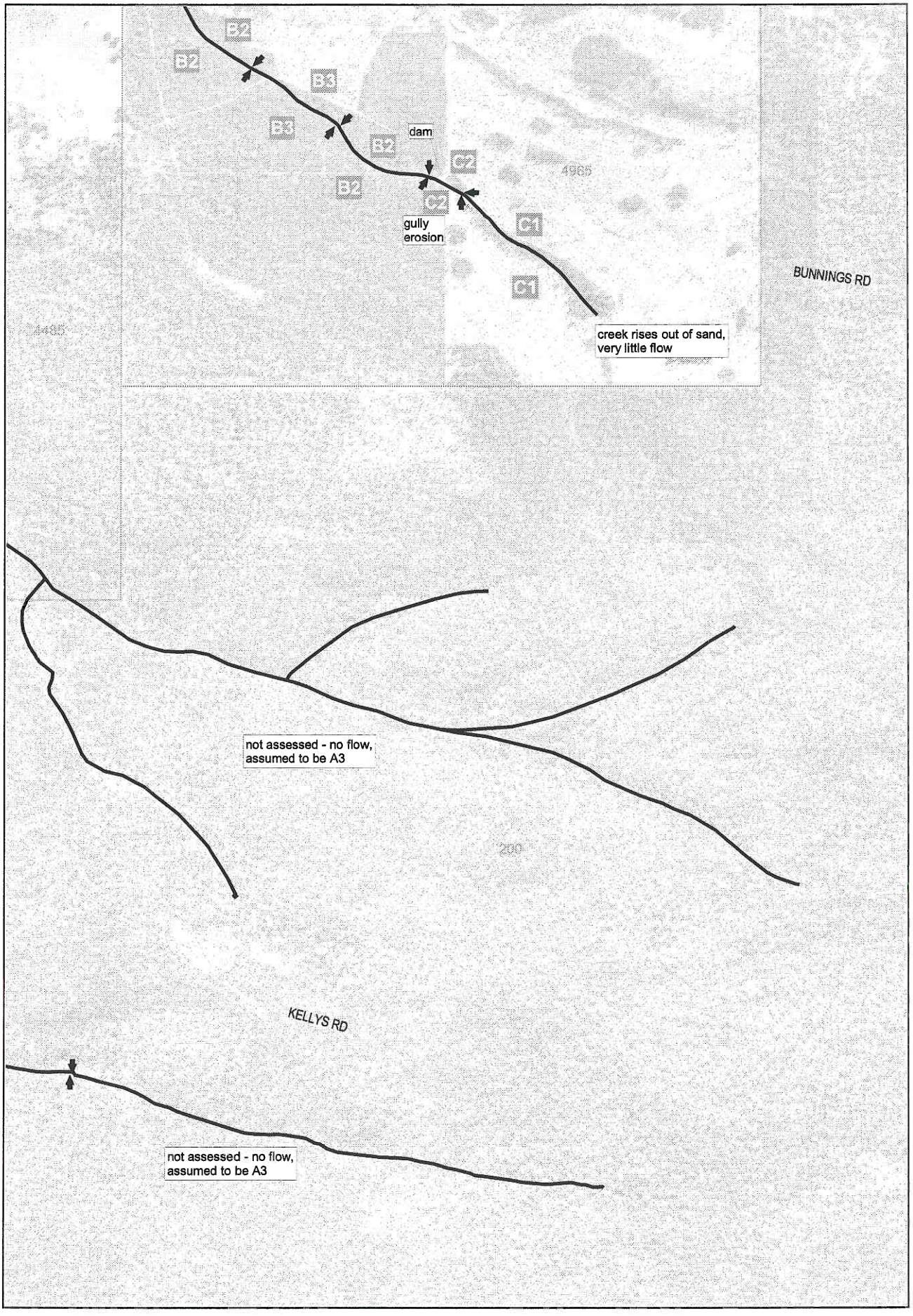
Two small tributaries of Gynudup Brook begin in State Forest 27, while a third forms on private property in a depression between rows of Bluegums. There are very minimal flows of all these waterways.

Land use in the area includes State Forest, light sheep and beef grazing and tree cropping.

Issues	Comments
Fencing	No part of these creeks has been fenced. The majority of the land here is State Forest, and not grazed. The remainder is a Bluegum plantation, and only lightly grazed.
Landform, soils and erosion	The creeks come off the Whicher Scarp into the Forrestfield System with rapidly draining, deeply bleached grey sands with some minor gravel. In parts, there are poorly drained deep bleached sands. Banks are generally stable, though rapid flow may cause incising. No major erosion apparent.
Native Vegetation	Jarrah and Marri open forest with a diverse understorey including Banksia, Woody Pear and Stirlingia.
Weeds	The area of State Forest was generally very healthy, however Capeweed, Inkweed, and annual grasses occur in parts.
Other comments, special features	Protection of the remnant vegetation in this section is very important as it is one of the few remnants of riparian vegetation in the catchment.

Map 20: Management recommendations and advice

- Fence the creek in Location 4965 to restrict stock access.
- Undertake feral animal control, especially of rabbits, as they can be a significant cause of bushland degradation.
- Ensure protection of high quality vegetation in State Forest, and Location 4965.
- In consultation with DCLM, undertake a more comprehensive vegetation survey of State Forest 27.Priority Actions



Gynudup Brook & Tren Creek Map 20

Priority actions

These actions are not listed in order of priority. Rather, they are grouped according to type of project. It should be noted that, although listed separately, a number of these projects could be combined (for example fencing and revegetating after erosion control measures are installed) to increase effectiveness and to reduce costs.

Project	What	Why	Who	When
Erosion control	**Drain erosion management demonstration site** Install a series of riffles using rock or large woody debris upstream and downstream of the Elgin Drain to slow water flows, trapping sediment and improving downstream water quality. Fence to restrict stock access and construct a series of stock crossings.	There are significant erosion and water quality issues as a result of the altered hydrological flow (due to the catchment clearing and the extensive drainage network) combined with clearing and degradation of riparian vegetation. Provides an ideal demonstration site to focus and increase community awareness of best management practice of erosion control in agricultural drains.	Landholders, LCDC, Landcare Officers, DoE engineers, plus in-kind support (materials, equipment and machinery).	Construction works need to be done in times of little or no flow, i.e. summer and autumn. Considerable planning and design will be required before construction can commence.
	Erosion management for drainage reserve 420. Address severe bank undercutting and slumping at Drainage Reserve 420 (Map 5) occurring due to increased water flows and stock access. Fencing to restrict stock access will be required.	The banks here are freely eroding and causing loss of land and fences. There is massive sediment transport downstream. Benefits of actions include improved waterways downstream.	Water Corporation, adjacent landholders, LCDC, DoE engineers plus in-kind support (materials, equipment and machinery).	Construction works need to be done in times of little or no flow, i.e. summer and autumn. Considerable planning and design will be required before construction can commence.
	Erosion management for Location 1017 Address headcutting where drain enters Tren Creek in Location 1017 (Map 1) by installing a rock chute, revegetating banks and upstream channel to slow water down, and fencing to exclude stock.	The drain is freely eroding and transports large amounts of sediment downstream. Additionally, landholder is losing land and fences are under threat. Benefits of actions include improved waterways downstream.	Landholder, LCDC, Landcare Officers, DoE engineers, plus in-kind support (materials, equipment and machinery).	Construction works need to be done in times of little or no flow, i.e. summer and autumn. Considerable planning and design will be required before construction can commence.

Project	What	Why	Who	When
Fencing	**Landcare Fencing Support** Apply for funding assistance for landholders to fence off remnant vegetation and the lengths of Gynudup Brook and Tren Creek. Target all sections of the waterways that are currently unfenced, and prioritise areas where there is some existing native vegetation that is under threat from grazing, for example on Gynudup Brook, west of Bussell Highway.	To prevent unrestricted stock access to local waterways as stock are a major cause of degradation of riparian vegetation in Gynudup Book and Tren Creek, resulting in loss of biodiversity and erosion.	Landholders, LCDC, GeoCatch and external funding sources such as NHT or EnviroFund.	On-going.
Revegetation	**Revegetation priorities** Undertake a series of projects to enhance existing riparian vegetation of Gynudup Brook and Tren Creek. Seriously consider strategic revegetation across the whole catchment, and prioritise areas where native vegetation remains, for example the area west of Bussell Highway. Stabilise eroding creeks and drains, if needed, as an essential component of revegetation projects.	Riparian vegetation is essential to bank stability and reducing erosion problems. To improve biodiversity and create a series of wildlife corridors for native fauna.	Landholders, LCDC, community nurseries or Boyanup Botanical, and external funding sources.	Seed collection should begin as soon as possible as spring/early summer is when the majority of local plants are holding seed. This seed should then be given to local nurseries to contract grow seedlings for plantings to begin in early winter. Erosion and weed control must be in place prior to planting if required at the site.
Weed control	**Community based weed control** Implement a catchment-wide approach targeted to specific weeds such as Arum Lily and Bridal Creeper.	To address a major cause of riparian vegetation degradation.	Landholders, Shire of Capel, LCDC and DoA.	Ongoing; specific timing depends on target weeds and control methods employed. Strategic community education activities are required to support the success of on-ground work.

Project	What	Why	Who	When
Collaborative management	**Working together to improve management** Share knowledge and develop a series of case studies of best practice for the transition to more sustainable land use. Contribute to the Natural Resource Management Strategy for the region and develop prioritised actions for environmental management in the Catchment.	To ensure that limited resources are best used to achieve desired outcomes. To support development of partnerships and better learning.	All stakeholders. landholders, LCDC, Shire (e.g. works, planning, parks and gardens), community groups, GeoCatch, SWCC, industry and State Govt. agencies (e.g. DCLM, DoE and DoA).	As soon as possible. Follow on from the launch of the plan and recent workshops held by GeoCatch to determine regional and sub-regional strategies and priorities.
Education	**Engage and support the community to learn** Construct a native fish/frog pond that is vegetated with local plant species, and use local waterways as part of the curriculum in collaboration with Capel Primary School, the LCDC, GeoCatch and Ribbons of Blue.	To foster a greater understanding and appreciation of the diversity of life and health of local waterways. To effect long-term change in community values and perceptions. To include children in landcare activities.	LCDC, Primary School, Ribbons of Blue, GeoCatch, Shire of Capel and WA Museum.	Ongoing.
	Community workshops and field days Run news stories, community workshops and field days to increase community capacity and desire for environmental restoration. Consider topics such as property planning, seed collection and propagation, and the use of local plants suitable and available for domestic gardens.	To increase the local community's awareness of, desire for, and capacity for environmental restoration at a property scale. To ensure an ongoing conversation about how to better manage waterways continues in the community through the media and community events.	LCDC, GeoCatch, Ribbons of Blue, APACE, local nurseries, and government agencies such as DoE and DCLM.	A series of three small farm management workshops to be held. A series of news articles informing about key issues as a regular feature in local papers.
	Water quality monitoring Expand the water quality monitoring regime across the catchment using Shire's Palin test kit to undertake monitoring of nutrient and turbidity levels in Gynudup Brook and Tren Creek.	To gain a more detailed understanding of the current health of Gynudup Brook and Tren Creek. To provide opportunities for the community and landholders to engage in water monitoring.	Landcare Officers, Ribbons of Blue, Shire of Capel.	Ongoing testing on a monthly basis in times of flow.

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Appendix 1. Native vegetation list for Gynudup Brook and Tren Creek

Page 93 lists vegetation types that were recorded in the study area, and locations where an example of each community may be found.

			Community Type				
Family	**Species**	**Common name**	**1**	**2**	**3**	**4**	**Habit**
FERNS							
Adiantaceae	*Adiantum aethiopicum*	Maidenhair Fern				✓	Herb
Azollaceae	*Azolla filiculoides*∞	Azolla	Channel				Water Fern
Dennstaedtiaceae	*Pteridium esculentum*	Bracken Fern	✓			✓	Shrub
GYMNOSPERMS							
Zamiaceae	*Macrozamia riedlei*	Zamia Palm	✓	✓		✓	Shrub
Podocarpaceae	*Podocarpus drouynianus*	Emu Bush	✓			✓	Shrub
MONOCOTYLEDONS							
Cyperaceae	*Baumea articulata*	Jointed Twig Rush			✓		Rush
	Baumea vaginalis	Sheath Twig Rush			✓		Rush
	Bolboschoenus caldwellii	Marsh Club Rush			✓	✓	Rush
	Carex tereticaulis				✓		Rush
	Chorizandra enodis	Black Bristle Rush			✓	✓	Rush
	Cyathochaeta avenacea				✓	✓	Rush
	Eleocharis glabra				✓	✓	Grass
	Ghania trifida	Coast Saw Sedge			✓		Sedge
	Isolepis nodosa	Knotted Club Rush			✓		Rush
	Lepidosperma effusum	Spreading Sword Sedge		✓			Sedge
	Lepidosperma leptostachyum					✓	Sedge
	Lepidosperma longitudinale	Pithy Sword Sedge	✓		✓	✓	Sedge
	Lepidosperma squamatum		✓			✓	Sedge
	Mesomalaena tetragona	Semaphore Sedge	✓			✓	Sedge
	Mesomalaena stygia		✓			✓	Sedge
	Schoenoplectus validus	Lake Club Rush			✓		Rush
	Schoenus curvifolius		✓				Rush
Dasypogonaceae	*Dasypogon bromeliifolius*	Drumsticks	✓			✓	Tufted Herb
	Dasypogon hookeri	Pineapple Bush	✓	✓			Grass Tree
	Kingia australis	Kingia	✓	✓		✓	Grass Tree
	Lomandra caespitosa	Tufted Mat Rush	✓	✓		✓	Grass
Haemodoraceae	*Anigozanthus flavidus*	Tall Kangaroo Paw	✓				Herb
	Anigozanthus viridis	Green Kangaroo Paw				✓	Herb
	Conostylis aculeata	Prickly Conostylis				✓	Herb
	Haemodorum spicatum	Bloodroot	✓			✓	Grass
Hydrocharitaceae	*Ottelia ovalifolia*	Swamp Lily	Channel				Water Lily
Iridaceae	*Patersonia occidentalis*	Purple Flag	✓	✓		✓	Herb
Juncaceae	*Juncus amabilis*				✓	✓	Rush

∞ It is under discussion whether this species is native or introduced.

			Community Type				
Family	**Species**	**Common name**	**1**	**2**	**3**	**4**	**Habit**
	Juncus kraussii	Sea Rush			✓	✓	Rush
	Juncus pallidus	Pale Rush			✓	✓	Rush
Juncaginaceae	*Triglochin lineare*	Water Ribbons	Channel				Emergent Water Herb
Orchidaceae	*Caladenia flava*	Cowslip Orchid				✓	Herb
	Gastrodia lacista	Potato Orchid				✓	Herb
Orchidaceae	*Leporella fimbriata*	Hare Orchid				✓	Herb
	Pterostylis spp	Snail Orchid				✓	Herb
Lemnaceae	*Lemna disperma*	Duckweed	Channel				Water Herb
Phormiaceae	*Dianella brevicaulis*	Blueberry Lily	✓	✓		✓	Herb
Poaceae	*Microlaena stypoides*	Meadow Rice Grass				✓	Grass
	Tetrarrhena laevis	Forest Rice Grass				✓	Grass
Restionaceae	*Alexgeorgea ganopoda*		✓			✓	Rush
	Hypolaena exsulca		✓		✓	✓	Rush
	Leptocarpus tenax	Slender Twine Rush				✓	Rush
	Loxocarya cinerea					✓	Rush
	Meeboldina scariosa	Velvet Rush	✓		✓	✓	Rush
Typhaceae	*Typha domingensis**	Narrow Leaf			✓	✓	
		Cumbungi, Bulrush					Rush
Xanthorrhoeaceae	*Xanthorrhoea brunonis*	Trunkless Grasstree				✓	Prostrate Grass Tree
	Xanthorrhoea gracilis	Graceful Grasstree	✓	✓			Prostrate Grass Tree
	Xanthorrhoea preissii	Grasstree	✓	✓		✓	Grass Tree
DICOTYLEDONS							
Amaranthaceae	*Alternanthera nodiflora*	Common Joyweed			✓	✓	Herb
Apiaceae	*Centella asiatica*	Pennywort, Centella			✓		Groundcover
Asteraceae	*Cotula coronopifolia*	Waterbuttons	Channel				Herb
Casuarinaceae	*Allocasuarina fraseriana*	Common Sheoak	✓	✓		✓	Tree
	Allocasuarina humilis	Dwarf Sheoak	✓	✓		✓	Shrub
Convolvulaceae	*Dichondra repens*	Dichondra, Kidney Weed			✓		Groundcover
Dilleniaceae	*Hibbertia cunninghamii*		✓	✓		✓	Small Shrub
	Hibbertia ferruginea			✓		✓	Small Shrub
	Hibbertia hypericoides	Yellow Buttercups	✓	✓		✓	Small Shrub
	Hibbertia stellaris	Orange Stars			✓	✓	Small Shrub
Droseraceae	*Drosera* spp	Sundews	✓			✓	Herb
Epacridaceae	*Leucopogon* spp		✓	✓		✓	Shrubs
Euphorbiaceae	*Phyllanthus calycinus*	False Boronia				✓	Shrub
Geraniaceae	*Geranium solanderi*	Native Geranium				✓	Herb
Lauraceae	*Cassytha racemosa*	Dodder Laurel			✓	✓	Parasitic Climber

* Although this is a local native species, it is easily confused with, and hybridises with an exotic species, *Typha orientalis*. For this reason, it is not recommended as a revegetation species, however, if already existing at a location, it is not recommended to remove it

			Community Type				
Family	**Species**	**Common name**	**1**	**2**	**3**	**4**	**Habit**
Lobeliaceae	*Lobelia alata*	Angled Lobelia			✓		Herb
Loranthaceae	*Amyema miquelii*	Stalked Mistletoe				✓	Parasitic Hanging Plant
	Nuytsia floribunda	Christmas Tree	✓	✓		✓	Parasitic Tree
Mimosaceae	*Acacia alata*	Winged Wattle		✓	✓	✓	Shrub
	Acacia cochlearis	Rigid Wattle				✓	Shrub
	Acacia extensa	Wiry Wattle		✓	✓	✓	Shrub
	Acacia flagelliformis		✓				Shrub
	Acacia paradoxa∞	Kangaroo Thorn	Revegetation Site				Large Shrub
		Hedge Wattle					
Mimosaceae	*Acacia pulchella*	Prickly Moses	✓	✓		✓	Shrub
	Acacia saligna	Orange Wattle				✓	LargeShrub/
							Small Tree
	Acacia semitrullata					✓	Small Shrub
	Acacia stenoptera					✓	Shrub
	Acacia urophylla	Tail-leaved Acacia		✓		✓	Shrub
Myrtaceae	*Astartea aff fascicularis*	Tea Tree	✓		✓		Shrub
	Agonis flexuosa	Peppermint			✓	✓	Tree
	Calytrix leschenaultii	Star Flower	✓				Shrub
	Corymbia calophylla	Marri	✓	✓		✓	Tree
	Corymbia haemotoxolon	Mountain Marri	✓	✓		✓	Tree
	Eucalyptus rudis	Flooded Gum			✓		Tree
	Eucalyptus gomphocephalus	Tuart				✓	Tree
	Eucalyptus marginata	Jarrah	✓	✓		✓	Tree
	Eucalyptus patens	Blackbutt			✓	✓	Tree
	Hypocalymma angustifolium	White Myrtle	✓		✓	?	Shrub
	Kunzea glabrescens	Spearwood			✓	✓	Shrub
	Melaleuca laterita	Robin Redbreast Bush	✓		✓	✓	Tall Shrub
	Melaleuca preissiana	Stout Paperbark			✓		Tree
	Melaleuca raphiophylla	Swamp Paperbark			✓	✓	Tree
	Melaleuca scabra	Rough Honeymyrtle	✓			✓	Shrub
	Melaleuca thymoides				✓	✓	Small Shrub
	Melaleuca uncinata	Broom Honeymyrtle			✓		Shrub
	Melaleuca viminea	Mohan			✓	✓	Shrub
	Pericalymma ellipticum	Swamp Tea Tree	✓		✓		Shrub
	Taxandria juniperina	Wattie			✓		Tall Shrub
	Taxandria linearfolia	Swamp Peppermint			✓		Tall Shrub
	Thryptomene saxicola	Feather leaf			✓		Shrub

∞ It is under discussion whether this species is native or introduced.

			Community Type				
Family	**Species**	**Common name**	**1**	**2**	**3**	**4**	**Habit**
Papillionaceae	*Bossiaea rufa*				✓	✓	Shrub
	Brachysema praemorsum					✓	Shrub
	Callistachys lanceolata	Native Willow			✓	✓	Tall Shrub
	Daviesia decurrens	Prickly Bitter Pea	✓			✓	Shrub
	Daviesia incrassata					✓	Shrub
	Daviesia inflata				✓	✓	Shrub
	Daviesia preissii		✓	✓		✓	Small Shrub
	Dillwynia uncinata	Silky Parrot Pea	✓	✓			Shrub
	Euchilopsis linearis	Swamp Pea			✓		Shrub
	Hardenbergia comptoniana	Native Wisteria	✓	✓	✓	✓	Climber
	Hovea trisperma	Common Hovea	✓	✓		✓	Small Shrub
	Jacksonia furcellata	Grey Stinkwood				✓	Shrub
	Kennedia coccinea	Coral Vine	✓			✓	Climber
	Kennedia prostrata	Running Postman		✓		✓	Shrub
	Mirbelia dilatata	Holly Leaf Mirbelia		✓		✓	Large Shrub
	Oxylobium lineare	Narrow Leaf Oxylobium			✓		Large Shrub
Papillionaceae	*Pultaenea skinnerii*✦	Skinners Pea			✓		Shrub
	Viminea juncea	Swishbush			✓	✓	Shrub/Small Tree
Pittosperaceae	*Sollya heterophylla*	Australian Bluebell	✓		✓	✓	Shrub
Proteaceae	*Adenanthos meisneri*		✓			✓	Shrub
	Banksia attenuata	Slender Banksia	✓	✓			Tree
	Banksia grandis	Bull Banksia	✓	✓			Tree
	Banksia ilicifolia	Holly Leaf Banksia	✓	✓		✓	Tree
	Banksia littoralis	Swamp Banksia	✓		✓	✓	Tree
	Dryandra aff lindleyana	Couch Honeypot	✓	✓		✓	Small Shrub
	Hakea varia	Variable Leaf Hakea	✓				Shrub
	Hakea lissocarpha	Honeybush	✓	✓		✓	Shrub
	Hakea prostrata	Harsh Hakea	✓	✓		✓	Shrub
	Hakea trifurcata	Two Leaf Hakea	✓			✓	Shrub
	Persoonia elliptica	Spreading Snottygobble	✓				Tree
	Persoonia longifolia	Snottygobble	✓				Tree
	Petrophile diversifolia		✓			✓	Shrub
	Stirlingia latifolia	Blueboy	✓	✓			Shrub
	Synaphea gracillima		✓	✓			Shrub
	Xylomelum occidentale	Woody Pear	✓	✓		✓	Tree
Ranunculaceae	*Clematis pubescens*	Old Man's Beard		✓		✓	Climber
	Ranunculus colonorum	Common Buttercup			✓		Herb
Rhamnaceae	*Spyridium globulosum*	Basket Bush				✓	Shrub
	Trymalium floribundum	Karri Hazel			✓	✓	Shrub

✦ Shire of Capel Floral Emblem and DCLM conservation status P4.

Community types

1. Banksia woodland with Jarrah and Marri. This only occurs on sandy soils at the foothills of the scarp. Parts of the State Forest and Locations 4485 and 4988 on Map 15, and Location 215 (Map 19) are good examples of this community type.
2. Jarrah and Marri open forest. A good example of this community type is in the State Forest above the foothills.
3. Flooded Gum and Paperbark low open forest. This is quite common in the western part of the catchment, and is generally relatively degraded with little understorey remaining in most parts. Locations 13 and 152 (Map 1) are a good place to see this community type.
4. Jarrah and Marri open woodland. This is also common in the western section, and is again generally quite degraded with limited understorey. A good example occurs in the northern parts where Gynudup Brook runs parallel to Bussell Highway (Map 20).

Appendix 2. Common weeds found in the study area

Family	Name	Common name
MONOCOTYLEDONS		
Alliaceae	**Agapanthus praecox*	Agapanthus
Amaryllidaceae	**Narcissus tazetta*	Jonquil
Araceae	**Zantedeschia aethiopica*	Arum Lily
Asparagaceae	**Asparagus asparagoides*	Bridal Creeper
Cyperaceae	**Cyperus congestus*	Dense Flat Sedge/Nut Grass
	**Cyperus eragrostis*	Umbrella Sedge
	**Isolepis prolifera*	Budding Club Rush
Iridaceae	**Chasmanthe floribunda*	African Cornflag
	**Freesia alba x leichtlinii*	Freesia
	**Gladiolus undulatus*	Wavy Gladioli
	**Ixia maculata*	Ixia
	**Romulea rosea*	Guilford Grass
	**Sparaxis bulbifera*	Harlequin Flower
	**Watsonia bulbillifera*	Bulbous Watsonia
Juncaceae	**Juncus articulatus*	Jointed Rush
	**Juncus microcephalus*	
Poaceae	**Avena barbata*	Bearded Oat
	**Briza maxima*	Blowfly Grass
	**Briza minor*	Shiver Grass
	**Bromus* spp	Brome Grasses
	**Cynodon dactylon var dactylon*	Couch
	**Eragrostis curvula*	African Love Grass
	**Ehrharta longiflora*	Annual Veldt Grass
	**Hordeum* spp	Barley Grasses
	**Lolium* spp	Rye Grasses
	**Paspalum dilatatum*	Paspalum
	**Paspalum distichum*	Water Couch
	**Pennisetum clandestinum*	Kikuyu
	**Phalaris aquatica*	Canary Grass
	**Poa annua*	Winter Grass
	**Vulpia* spp	Fescue
Typhaceae	**Typha orientalis*	Broad Leaf Cumbungi, Bulrush
DICOTYLEDONS		
Apocynaceae	**Vinca major*	Blue Periwinkle
Asclepiadaceae	**Gomphocarpus fruiticosa*	Narrow Leaf Cotton Bush
Asteraceae	**Arctotheca calendula*	Capeweed
	**Aster subulataus*	Bushy Starwort
	**Carduus tenuiflorus*	Sheep's Thistle
	**Conyza albida*	Fleabane
	**Cotula turbinata*	Funnel Weed
	**Dittrichia graveolens*	Stinkwort
	**Hypochaeris glabra*	Flatweed

Family	Name	Common name
	**Pseudognaphalium luteoalbum*	Jersey Cudweed
	**Sonchus* spp	Sow Thistle
DICOTYLEDONS		
Brassicaceae	**Raphanus raphanistrum*	Wild Radish
Callitrichaceae	**Callitriche hamulata*	
	**Callitriche stagnalis*	Common Starwort
Caryophyllaceae	**Spergula arvensis*	Corn Spurry
Chenopodiaceae	**Chenopodiaceae album*	Fat Hen
	**Chenopodiaceae ambrosioides*	Mexican Tea
Cucurbitaceae	**Cucumis lanatus*	Pie Melon
	**Cucumis myriocarpus*	Prickly Paddy Melon
Euphorbiaceae	**Euphorbia peplus*	Petty Spurge
Fumariaceae	**Fumaria capreolata*	White Fumitory
Geraniaceae	**Erodium botrys*	Long Storksbill
	**Erodium cicutarium*	Common Storksbill
Lamiaceae	**Mentha pulegium*	Pennyroyal
	**Stachys arvensis*	Stagger Weed
Malvaceae	**Malva parviflora*	Mallow
Onagraceae	**Oenthera stricta*	Common Evening Primrose
Oxalidaceae	**Oxalis glabra*	Fingerleaf Oxalis
	**Oxalis pes-caprae*	Soursob
	**Oxalis purpea*	Four O'clock
Papillionaceae	**Chamaecytisus palmensis*	Tagasaste
	**Lotus angustissimus*	Narrowleaf Trefoil
	**Lotus suaveolens*	Hairy Birdsfoot Trefoil
	**Lupinus cosentinii*	West Australian Blue Lupin
	**Medicage polymorpha*	Burr Medic
	**Ornithopus pinnatus*	Slender Serradella
	**Trifolium* spp	Clovers
Passifloraceae	**Passiflora edulis*	Passionfruit
Phytolaccaceae	**Phytolacca octandra*	Inkweed
Plantaginaceae	**Plantago lanceolata*	Ribwort Plantain
Polygonaceae	**Acetosella vulgaris*	Sorrel
	**Emex australis*	Doublegee
	**Polygonum aviculare*	Wireweed
	*Rumex obtusifolias	Broadleaf Dock
	**Rumex pulcher*	Fiddleleaf Dock
Primulaceae	**Anagalis avensis*	Pimpernel
Rosaceae	**Rosa* spp	Rose
	**Rubus fruticosus*	Blackberry
Solanaceae	**Solanum linnaeanum*	Apple of Sodom
	**Solanum nigrum*	Black Berry Nightshade
Urtricaceae	**Soleirolla soleirolii*	Baby's Tears

Appendix 3. Planning advice from the Vasse River Action Plan

The following planning advice is taken from the Vasse River Action Plan and was prepared by Marg Scott and Jenny Dewing (GeoCatch, 2003).

Planning a project

Write down your objectives:

- What work will be done?
- Who will do the work?
- What will the work achieve?
- Who and what will benefit from the work?

A written list of objectives:

- helps planners to stay within the goals;
- encourages recruitment of volunteers;
- helps volunteers to understand their roles; and
- provides benchmarks of progress and success.

Site selection:

- Choose a workable-sized site, small enough to complete the job.
- Select a site within easy travelling distance for volunteers.
- Favour a site which enables the volunteers, and if possible the general public, to view their achievements.

Organising a planning committee:

- Select a diverse group of people with various skills and interests.
- Choose leaders in the community.
- Draw on different groups of people within the community.
- Identify those people with supervising and planning skills.
- Enlist the local media to contribute their support.

Planning creek rehabilitation

Planning a revegetation project should commence in the year preceding the proposed planting or seeding and include researching the best revegetation approach.

Issues to be addressed include:

- the design of remedial work on the banks;
- the selection of suitable plant species;
- how to propagate (by green stock or direct seeding);
- where to obtain seed;
- who to get to propagate the seed;
- the position and design of fencing;
- identifying likely weed problems, developing a weed action plan; and
- where to access funds if you intend applying for a grant.

It is essential to study the project site thoroughly. A thorough site survey will provide an inventory of assets such as:

- existing indigenous vegetation;
- plants that are naturally regenerating;
- seed sources;
- potential problems, for example, rabbit activity, weed infestations, eroding banks, areas of sedimentation.

The survey may result in the decision to manage the area to encourage natural regeneration rather than to restore the native vegetation by planting or direct seeding.

A survey can also be used for monitoring the effectiveness of a particular management activity over time.

Bank erosion and/or sedimentation may require remedial action prior to revegetation. Advice should be sought from the Department of Environment.

When to survey

Late autumn to early winter is a good time to survey when weed problems are apparent. Impacts of river activity can be easily seen – sections of eroding or slumping banks, and areas where sediment is being deposited. Later in winter, a survey of the river or stream in full flow is more likely to reveal the behaviour of the river rather than its impact.

What's growing on the creek or river bank

A list of existing native vegetation is useful for identifying suitable plant species for revegetation and potential populations of plants for obtaining seed. It is important to establish the position on the stream bank that each plant occupies and the type of soil in which it grows – sand, clay, loam etc.

Native plants are easier to identify when flowering. While different species flower in different seasons throughout the year, the peak season is spring. Fringing species flower later to coincide with falling water levels. They flower and produce seed after winter flooding, to complete their cycle before the next winter rains. It may take several visits from winter onwards to identify all plants.

In summer, flowering suites of plants go mostly unnoticed as they flower when few people are walking and looking. Some of these include Astartea fasicularis (a tea tree), Taxandria linearfolia (swamp peppermint) and Banksia littoralis (swamp Banksia).

There is a slightly different community of plants growing along the banks of each local creek. These variations reflect the topographical features of the landscape and the soil types unique to that site.

It is not difficult to compile a list of plants specific to a site. The revegetation is then tailored to suit local insects, reptiles, frogs, birds and small mammals, and looks similar to existing remnant vegetation.

Identifying plants

Native rushes and sedges are difficult for untrained people to identify, and are often excluded from revegetation plant lists. The easiest way to identify them is to collect samples, including the base of the plant, and compare them with specimens in the regional or state herbarium. Generally perennial grasses, including spear, wallaby and kangaroo grasses, flower from late spring to summer. Rushes flower at the same time, while sedges flower from late spring through to autumn, depending on the species. These are important plants that help to hold the bank together, acting as 'foot soldiers' to the trees.

Where most understorey plants have been lost through clearing and grazing, selecting a vegetated site nearby with similar soil type and topography will assist in compiling a species list to use.

The Department of Conservation and Land Management (DCLM) publication How to Create a Local Herbarium is recommended for landholders who wish to collect and preserve their own set of field specimens.

Appendix 4. Useful contacts and phone numbers

Capel LCDC
PO Box 82, Capel, 6271

Capel Landcare Officers
Shire of Capel, Forest Road, Capel, 6271
Ph: 9727 2030

GeoCatch
PO Box 269, Busselton, 6280
Ph: 9781 0111
Fax: 9754 4335
Email: geocatch@environment.wa.gov.au
Web: http://www.geocatch.asn.au

Department of Agriculture (Busselton)
RSM 184, Busselton, 6280
Ph: 9752 1688
Web: http://www.agric.wa.gov.au

Department of Conservation and Land Management
14 Queen Street, Busselton, 6280
Ph: 9752 1677
Web: http://www.naturebase.com.au

Department of Environment Bunbury
35-39 McCoombe Rd, Bunbury.
PO Box 261, Bunbury, 6231
Ph: 9726 4111
Web: http://www.environment.wa.gov.au

Ribbons of Blue
GeoCatch
PO Box 269, Busselton, 6280
Ph: 9781 0111
Fax: 9754 4335
Email: geocatch@environment.wa.gov.au
Web: http://www.geocatch.asn.au

Water Corporation (Busselton)
PO Box 453, Busselton, 6280
Ph: 9752 3601
Web: http://www.watercorporation.com.au