Restoring the Health of the Little River:

Riparian Survey and Management Recommendations for Repairing the Little River Catchment near Denmark, WA.

1996

A report prepared for
the Denmark Environment Centre
by Apace Green Skills

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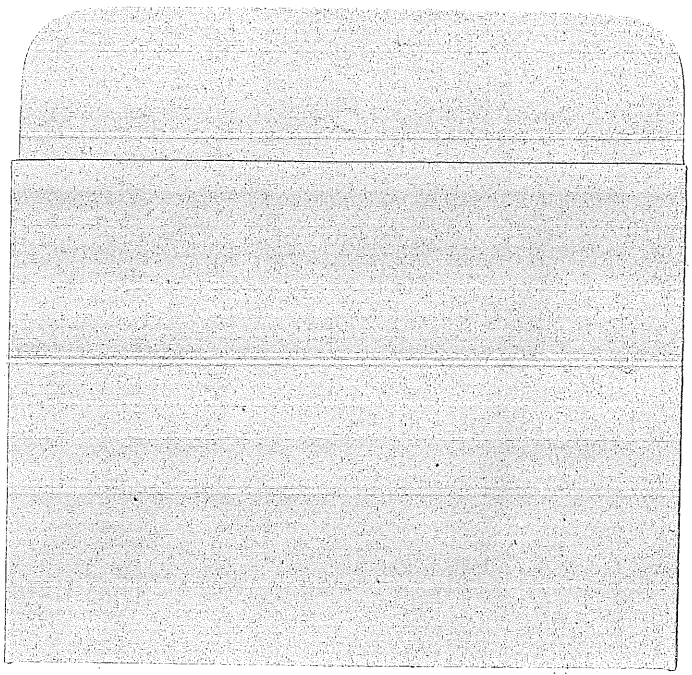

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A survey project funded by :
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ACKNOWLEDGMENTS

Apace Green Skills would like to acknowledge the support of farmers and farm managers in the Little River catchment, without whose cooperation the survey would not have been possible.

The Shire of Denmark, and the Denmark Land Conservation District Committee gave their endorsement for the survey to go ahead.

Three studies provided the foundation on which the current report was based. The first by Dr Luke Pen, surveyed the condition of the Kalgan River foreshore (Pen, 1994), the second, by Geraldine Janicke, provided an inventory of plant species found at six sites along the Denmark and Hay Rivers (Janicke, 1994). The third surveyed the condition of the Hay and Denmark river foreshores (Apace Green Skills and Dr Luke Pen, 1995).

Dr Luke Pen has kindly agreed to the inclusion of information in this report developed by him in the reports on the condition of the Kalgan, Hay and Denmark rivers.

The on-ground survey work for the Little River was carried out by Alex Syme in conjunction with local landholders. Alex Syme did much of the farmer liaison and preparation of tables for the report. Diane Harwood provided advice on weed control and bushland management. Basil Schur and Louise Duxbury supervised the overall project for Apace Green Skills. Other Green Skills staff who assisted in the project included Gerda Vogt, Biddy Myres, Chris Baillie, Louise Duxbury and Sally Haigh. Layout and final editing of the report was by Simon Neville.

Kim Greenham of Watershed Digital Mapping produced the maps for the project, entered the survey data onto Geographic Information System (GIS) and digitised the remnant vegetation for the catchment. A special thanks goes to Kim for the considerable extra work done by him.

Mark Parre conducted a botanical survey of key sites within the Little River catchment and provided advice on endemic species suitable for revegetation in the catchment.

A consultancy study for the Denmark Environment Centre, by Angus MacKenzie, (MacKenzie, 1996) identifies the main areas of erosion and related factors along the Little River itself and its findings have been referred to in this report.

Thanks must go to Arno Funck and the Management Committee of the Denmark Environment Centre and Anthony Sutton of the Wilson Inlet Management Authority for their encouragement and support in carrying out this work and for reviewing the manuscript of this report. Their comments and suggestions have been invaluable.

The overall survey project was funded by the Gordon Reid Foundation for Conservation (part of the WA Lotteries Commission) and the Wilson Inlet Management Authority.

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1. READ THE REPORT (THE SUMMARY AND SECTIONS 1 THROUGH TO 6), IN PARTICULAR THOSE PARTS RELATING TO YOUR AREA(S) OF INTEREST.

2. USE THE MAP INDEX (MAPS 1.2 ON PAGE 6) TO FIND YOUR APPROXIMATE PROPERTY LOCATION ON THE DETAILED MAP SHEETS - THESE ARE MAPS NOS. 1 - 22.

   THE LITTLE RIVER MAPS ARE IN CHAPTER 7

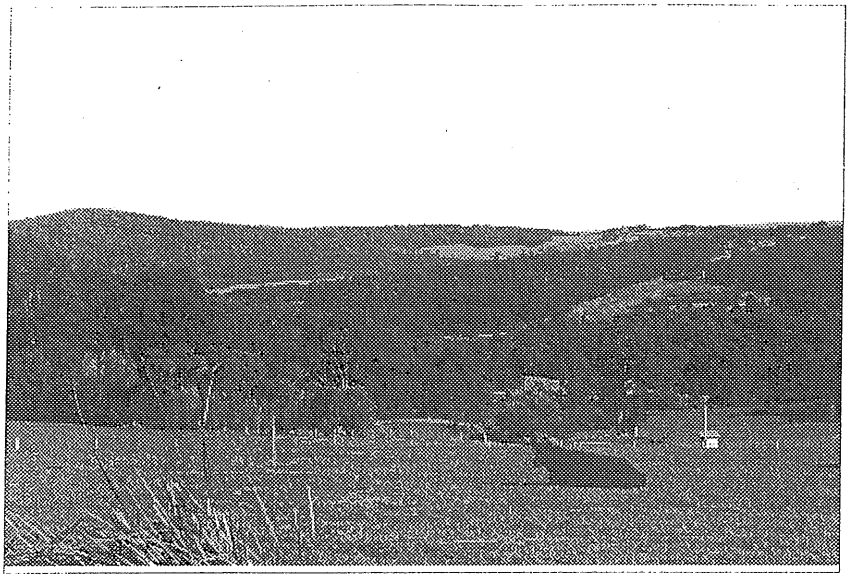
3. FIND THE MAP CONTAINING YOUR PROPERTY. (THIS WILL REQUIRE SEARCHING FOR YOUR LOCATION OR LOT NUMBER, USING LOCAL LANDMARKS).

   EACH SUB-SECTION MAP HAS A TABLE FACING IT WHICH GIVES MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS.

4. USE THE DETAILED LEGEND TO UNDERSTAND THE MAP REFERRING TO YOUR PROPERTY.

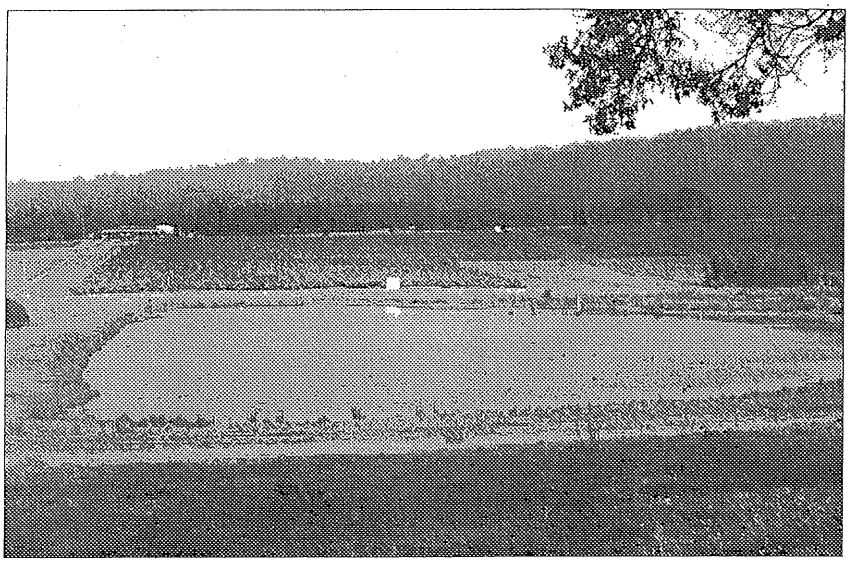
5. USE THE TABLE AND THE SUB-SECTION MAP TO DETERMINE WHAT RECOMMENDATIONS HAVE BEEN MADE FOR YOUR PROPERTY.

NOTE: THE 'LEFT' AND 'RIGHT' BANKS ARE AS SEEN LOOKING UP RIVER



General view over Little River Valley from Mt. Shadforth Road, looking south, with Mt Hallowell in the background. Significant areas of high quality remnant forest remain in the catchment.

View over tributary of Little River, looking north east from Sunrise Road towards Mt Shadforth. It is recommended that remnant vegetation along this tributary be permanently fenced from stock.



Major dam on Little River. This photograph was taken from South Coast Highway looking south. Construction of islands, and revegetation of some of the dam's fringe with native vegetation, would greatly enhance its value for bird habitat. The dam's spillway channel needs repair to allow for native fish migration.

SUMMARY

The Wilson Inlet, on the south coast of Western Australia and adjacent to the township of Denmark, is a regionally significant estuary. Currently it is threatened by eutrophication, due mainly to excessive nutrient input from agricultural areas in the catchment. The catchment area of the Inlet covers 2363 square kilometres, comprising mainly farmland and Crown land.

The Denmark and Hay Rivers are the two major tributaries of Wilson Inlet with the Sleeman River, Cuppup Creek and Little River being smaller but significant tributaries.

The large quantities of nutrients and sediment that each year discharge into Wilson Inlet come principally from the Sleeman, Little, Hay and Denmark Rivers, and the Cuppup Drain and their tributaries. These nutrients have the potential to cause algal growth which could smother the *Ruppia* seagrass meadows of the Inlet. Research has highlighted the importance of streamline fringing vegetation in attenuating nutrient and sediment loss from agricultural areas into waterways.

There is an increasing call from the local rural community for the rivers and other watercourses of the catchment to be fenced. This would protect these large natural bio-filters and prevent erosion of the riverbanks, which occurs when the protective fringing vegetation is lost through livestock grazing and trampling.

To assist with the process of catchment repair, the Denmark Environment Centre commissioned Apace Green Skills to carry out a survey to assess the condition of the foreshores of the Little River and its tributaries. The survey commenced in August 1996 and concluded in September 1996.

This work graded the condition of sections of foreshore of each river bank into three categories: (A) pristine to slightly disturbed, (B) degraded, (C) erosion prone to eroded, and (D) eroding ditch or weed infested drain; on the basis of weed infestation, soil exposure and erosion. The extent of riverbank fencing and revegetation, and the general quality of the fringing vegetation were also assessed.

Foreshore condition and fencing status were assessed in detail along with fencing and rehabilitation needs and other information and the results were then collated.

In total, 48.5 kilometres of the Little River and its tributaries were surveyed. Of this length, about 34% of the riparian zone was A grade, 22.5% B grade, 26% C grade and 17.5% D grade. Overall, about 57 ha of river valley embankment and foreshore requires revegetation to stabilise the banks, and maintain both aquatic and terrestrial corridors.

In areas where farmland adjoined the Little River and its tributaries, approximately 47% of the foreshore was already fenced. A further 59 km of fencing is required which includes fences that need relocating further away from the main channel.

The Little River and its tributaries have many points of erosion and subsidence with significant sections of degradation in several tributaries. Deposits of course sediments were observed frequently in the river bed. Fencing has been placed along some of these sections recently, but has been placed with insufficient distance from the waterway to provide an effective buffer. To protect riverine fringing vegetation and thereby maintain its bio-filtering and erosion control functions, fencelines need to be located above the river valley and, in the case of steep valley embankments, well above it. In some sections of eroding watercourse or dam spillways, soft-engineering approaches (eg construction of pool and riffle systems) are required. Notwithstanding the above, significant sections of the river and tributaries were found to be very scenic and contained foreshores of a high quality.

The findings and recommendations of the survey are designed to provide advice and encouragement to landholders and managers to carry out measures which protect and restore river and stream foreshore condition. Farmers who wish to receive support for fencing rivers, streams or drains on their properties may apply for assistance from the Wilson Inlet Management Authority and the Shire of Denmark under fencing subsidy programs currently in place for the Wilson Inlet catchment.

The Little River catchment is intensively used for small farms and residential development. In addition to protection, revegetation and weed management of the fringing vegetation of waterways it is recommended that all landusers:

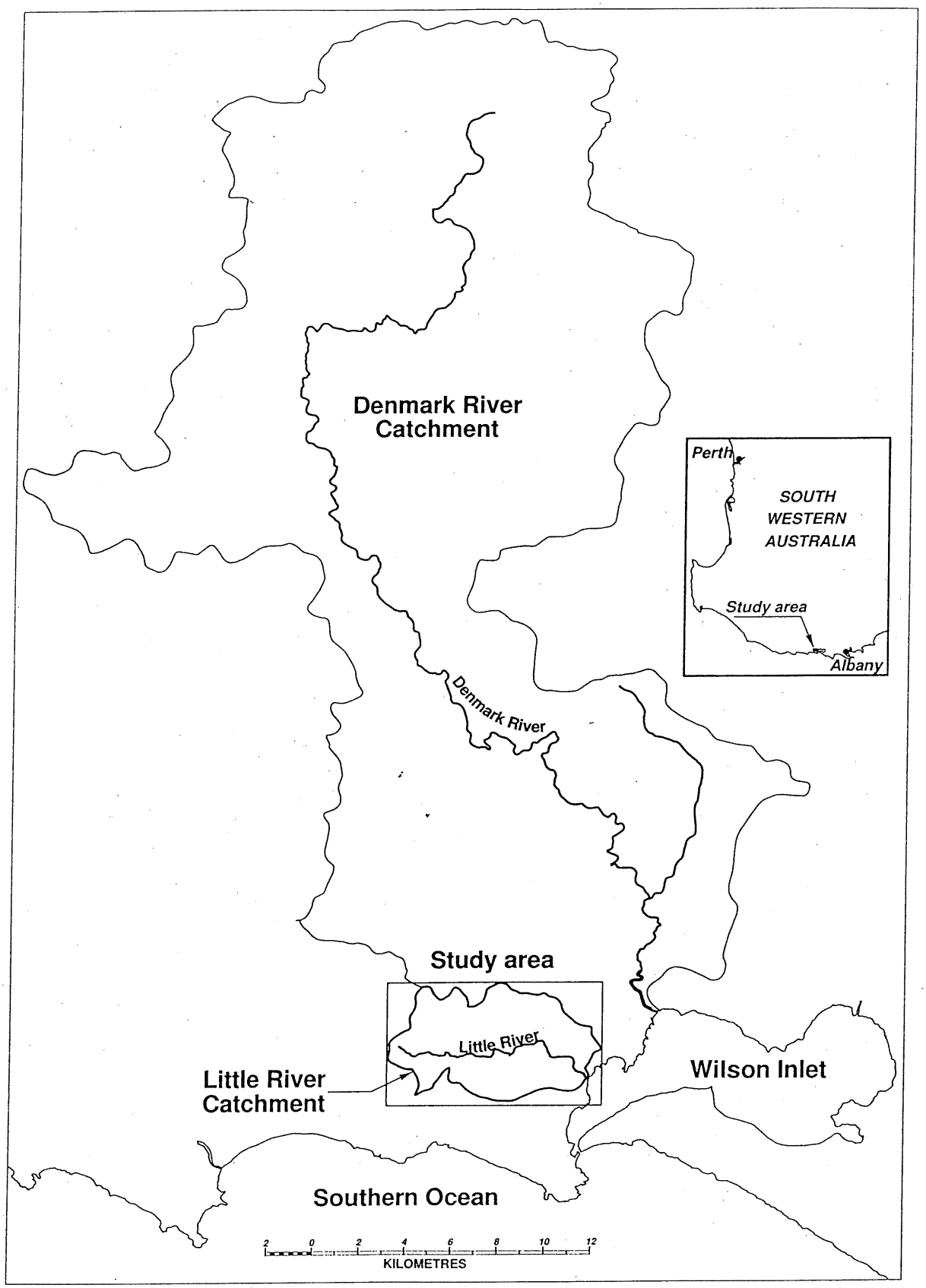
- increase the use perennial grasses, shrubs and trees
- avoid clearing of remnant native vegetation
- obtain environmental management advice and approvals prior to constructing dams or any other structures affecting watercourses
- investigate alternate stock crossing structures, where problems are occurring
- assist with construction of pools and riffles and dam overflow structures in certain sections of the catchment where recommended by MacKenzie (1996)
- be encouraged to form and participate in a Little River catchment group, with the aim of formulating a management plan.

Because important species of native fish still occur in the Little River catchment (including Night fish Bostockia porosa, pouched lamprey Geotria australis, possibly Galaxid minnows and Marron(Cherax tenuimanus)), it is recommended that a management plan be developed with landholders to protect native fish and crayfish from introduced fishes and crayfish.

Those landholders with farming enterprises in the Catchment are encouraged by Agriculture Western Australia to minimise nutrient loss to waterways by:

- regular soil testing and use of the PHOSUL-K fertiliser recommendations;
- the maintenance of adequate ground cover through stock management;
- the diversification into alternative enterprises on low nutrient retentive sites; and
- the integration of all these measures through whole farm planning.

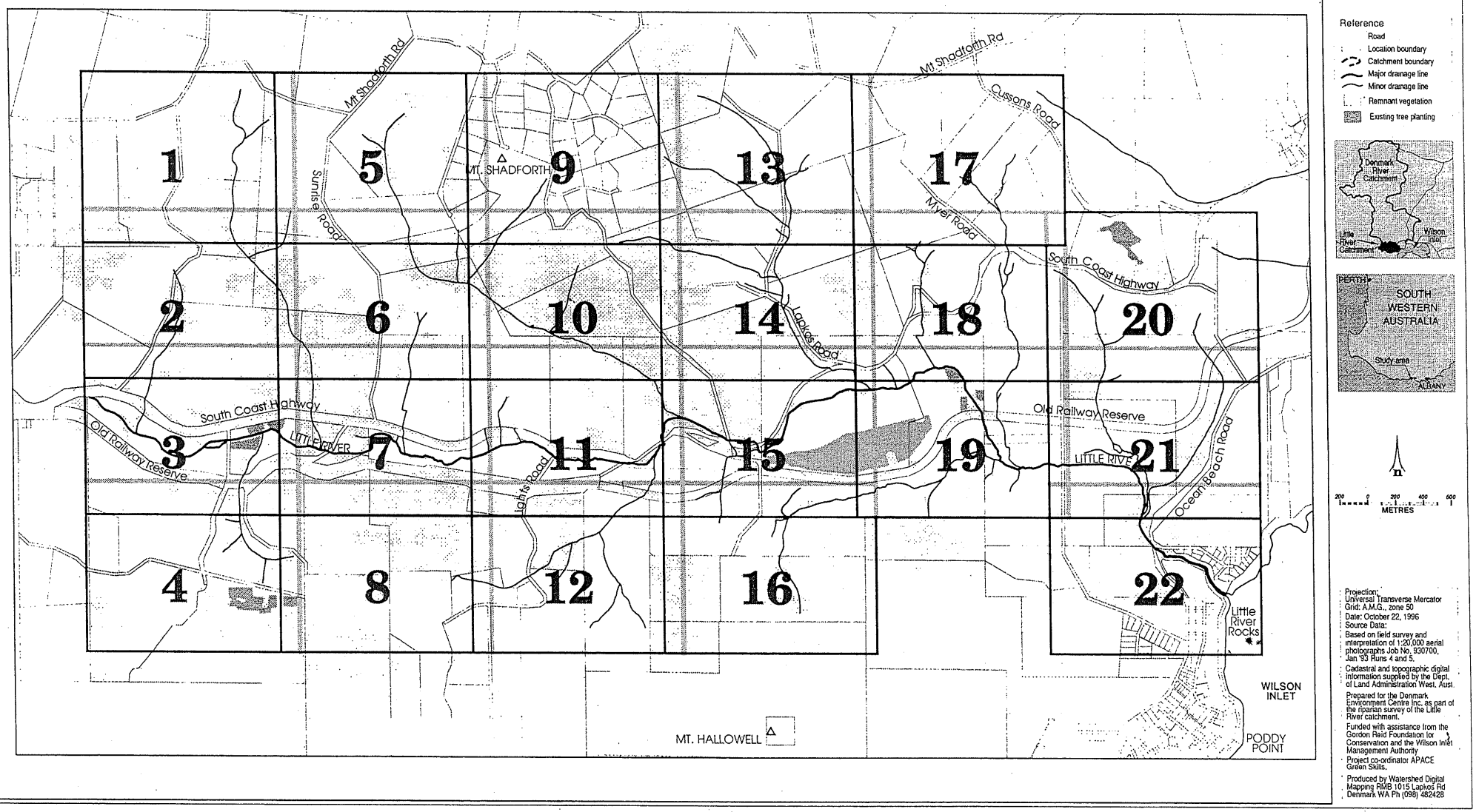
This report is part of an approach whereby Government agencies and community landcare groups cooperate with all landusers to assist in protecting the health of a much valued south coast estuary and its associated waterways.



Map 1.1 Location Map for the Little River Catchment

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

BASE MAP AND MAPSHEET INDEX



Reference
- Road
- Location boundary
- Catchment boundary
- Major drainage line
- Minor drainage line
- Remnant vegetation
- Existing tree planting

Projection:
Universal Transverse Mercator
Grid: A.M.G., Zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job No. 930700, Jan 93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Reid Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

Map 1.2 Base Map and Map Sheet Index for the Little River Catchment

1. INTRODUCTION

1.1 Aims of the study

The aims of the survey were as follows:

1. Survey the condition of the Little River and its tributaries and its fringing vegetation using the system outlined in Section 3.2;

2. Map points of serious erosion;

3. Map the extent of fencing along the river and tributaries;

4. Provide a general description of the fringing vegetation and landscape;

5. Assess the health of the vegetation along the river and tributaries; and

6. Provide a preliminary series of recommendations for rehabilitation work along the foreshores of the river and its tributaries. These recommendations were designed to provide encouragement and advice to landholders and agency managers for future riparian repair work.

1.2 Study area

The study area consists of the land along the Little River and its tributaries between where they commence in the catchment and where Little River empties into Wilson Inlet (see Map 1.1- Little River catchment index map). The area includes the channel embankments, the floodways and floodplains of the river and its tributaries, the valley embankments of the river and tributaries which rise immediately above them and the land use adjacent to the river and its tributaries (see Fig. 2.1 for an explanation of the terms used to describe river valley form).

1.3 Study background

The Wilson Inlet, on the south coast of Western Australia and adjacent to the township of Denmark, is a regionally significant estuary. Currently it is threatened with eutrophication, due mainly to excessive nutrient input from agricultural areas in the catchment. The catchment area of the Inlet covers 2363 square kilometres mainly comprising farmland and Crown land.

Studies over the past decade reveal that Wilson Inlet is showing signs of eutrophication. Symptoms include the excessive accumulation of plant material and organic ooze.

Studies carried out for Agriculture Western Australia's Wilson Inlet Catchment Project in 1994 estimated that the total phosphorus load entering the Inlet was approximately 24 tonnes. The Hay River was estimated to contribute 4 tonnes, the Sleeman River 7.4 tonnes and the Cuppup Creek 8.3 tonnes. Because of similarities of the Denmark and Hay River catchments, Agriculture Western Australia assigned a phosphorus load of 4 tonnes for the Denmark River and did not estimate a nutrient load for the Little River. More than 70% of the phosphorus load was estimated to be in particulate form, that is, it is attached to soil particles.

In an effort to control nutrient loss to rivers entering Wilson Inlet, a catchment management strategy is being developed, involving the urban and rural community and government agencies. In the general area of the Wilson Inlet catchment, three Land Conservation District Committees (LCDCs) work at a local level to arrest land degradation and reduce nutrient loss. In order to coordinate catchment management work by the LCDCs within the catchment, the Wilson Inlet Catchment Committee (WICC) was formed.

It is supported by the South Coast Estuaries Project (SCEP) of Agriculture Western Australia, which investigates and promotes sustainable agricultural systems. In addition there are a number of other Denmark based conservation organisations which are working towards catchment repair. As the primary source of nutrients entering the Inlet comes from broad acre agriculture, recommendations have been developed that primarily focus on farmers in the catchment area.

Actions recommended by SCEP, that landholders can take to minimise nutrient loss to waterways include:

- regular soil testing to determine fertiliser needs;
- increasing the use and acceptance of the PHOSUL-K fertiliser recommendations;
- changing fertiliser application and timing;
- increasing use of deep-rooted plants, perennial grasses, shrubs and trees;
- protecting and rehabilitating stream line vegetation to provide filtering of run off water;
- reducing drainage and promoting on-farm water use;
- increasing water infiltration and soil water storage;
- using soil amendments such as lime;
- protecting wetland areas from stock;
- minimising clearing of remnant bush;
- maintaining adequate ground cover by better stock management;
- using farm planning as a tool for land management;
- diversifying into alternative enterprises where the nutrient retention capacity of soils is low; and
- promoting sound effluent management for intensive animal industries (Prout, 1995).

SCEP's research has shown that nutrient loss from the catchment reaches maximum levels during high intensity rainfall events during which runoff causes widespread erosion in the catchment (SCEP, 1991). Eroded soil from these events is usually richer in nutrients than the original field soil and large quantities can be washed into Wilson Inlet.

SCEP has emphasised the need for placement and maintenance of vegetative strips along streams and rivers. Such fringing vegetation acts to prevent erosion, filter out suspended solids during flood events and assimilate nutrients carried in runoff (Weaver *et al.*, 1994; SCEP, 1991; Weaver and Prout, 1993).

In the Wilson Inlet catchment, there has been a watercourse fencing and regeneration program coordinated by the Denmark Environment Centre since 1989. This has been financially supported by landholders, the Shire of Denmark, the Save The Bush Program of the Australian Nature Conservation Agency, and the Wilson Inlet Management Authority. The program involves landholders applying for grants for watercourse fencing. Between 1989 and June 1995, $52,600 of fencing subsidy grants had been allocated to farmers. This supported 135 km of fencing on 75 watercourse and river fencing projects on 45 farms within the Wilson Inlet catchment area (Denmark Environment Centre, 1995).

In recognition of the value of foreshore vegetation, the Denmark Environment Centre Inc. working with Apace Green Skills, received funding from the Wilson Inlet Management Authority and the Gordon Reid Foundation for Conservation, to undertake a survey of the condition of the foreshores of the Little River and its tributaries. This report contains the results of that survey.

1.4 Description of the region

The Little River catchment drains about 1.5% of the catchment of Wilson Inlet which is situated on the south coast of south-west Western Australia. The river catchment stretches west of Denmark (Map 1.1).

The Wilson Inlet catchment covers an area of about 2363 km^2. The major waterways of the catchment are the Hay, Denmark, Sleeman and Little Rivers, and the Cuppup and Lake Saide drains. The Little River catchment covers

approximately 32 km^2 (3200ha) with 38 % of the catchment is still under remnant vegetation. Little River is a permanent stream 10.5 km long, and the combined length of drainage lines in its catchment is 24 km. (MacKenzie, 1996:2)

The climate of the catchment is temperate and mild, with rainfall of 1100-1200 mm mostly confined to winter and early spring with evaporation of 1200 mm (Collins and Fowlie, 1981).

As with virtually all south-west rivers, the Little River catchment exhibits a discharge pattern which reflects the seasonal rainfall: strong flows over the winter/spring period and moderate to negligible flows over the summer/autumn period. (DPUD, 1991).Although total annual rainfall has decreased, the volume and speed of runoff has increased because of removal of native vegetation (MacKenzie, 1996)

The natural vegetation of the Little River catchment is predominantly forest with a great range of forms and diversity of species. The coastal dunes carry thickets of Peppermint scrub and heath with reed swamps in low lying areas. Karri forest occurs in the hilly country, usually on loamy soils derived from granite outcrops or along the incised valleys. Jarrah forest formations dominate over much of the area. Within the area there are broad swampy drainage lines which currently or used to carry Paperbark or Banksia woodlands and reed swamps, with sandy flats subject to seasonal inundation bearing low woodland of Jarrah, Marri, Wandoo or Swamp Yates (Collins and Fowlie, 1981).

The Little River catchment has seen major modifications. Historically it has been affected by clearing for agriculture (62 % cleared), logging, road and rail construction (MacKenzie, 1996). Most of the remnant vegetation on farms is unfenced and subject to livestock grazing and trampling.

1.5. Value of fringing vegetation in catchment management

1.5.1 Stream bank stabilisation and soil conservation

The soils of the natural stream valley support a varied flora of trees, shrubs, sedges and herbs. In turn, the vegetation supports the stream bank and protects it from erosion and subsidence. The vegetation does this in a number of ways. Firstly, fringing vegetation increases stream bank roughness which acts to dissipate the energy of running water, with the effect of reducing the erosive capacity of the stream flow (Troeh *et. al.,* 1980). Secondly, roots and rhizomes bind and reinforce the soil of the embankments. The large roots of trees anchor the embankment in place and the smaller roots and rhizomes of shrubs, sedges and grasses hold the soil firmly in place at the surface of the ground between the large tree roots. In fact, the soil-root matrix can add extra cohesion of the order of ten times that of an unvegetated embankment (Thorne, 1990).

The roots and rhizomes also act to loosen and break up the soil, with the result that a well vegetated bank enables rapid infiltration of rain water (Thorne, 1990; Riding and Carter, 1992). Together with the extraction of the water by the plants themselves, greater hydrological conductivity causes the bank to be drier than a similar unvegetated bank. In wet weather, this means that the vegetated embankment is less likely to become saturated with water, and thus is less prone to mass failure, such as subsidence and toppling caused by the added bulk weight of the water (Thorne, 1990).

Lastly, riparian vegetation is highly resilient, exhibiting quick regeneration and recolonisation following the effects of severe floods. In this way the vegetation helps stabilise the river system against the effects of severe erosion and siltation (DeBano and Schmidt, 1990; Wissmar and Swanson, 1990).

1.5.2 Sediment and nutrient retention

Research being carried out in Europe, North America and New Zealand increasingly highlights the important function that riparian zone vegetation has in filtering out sediment and nutrients carried in flowing waters. Work on vegetated buffer strips along waterways or between waterways and agricultural land has shown that vegetation of many forms, including grasslands, sedgelands, woodlands and forests, can filter out and retain substantial amounts of sediment and

nutrients (Peterjohn and Correll, 1984; Cooper *et al.*, 1987; Dillaha *et al.*, 1988, 1989; Heede, 1988; Knauer and Mander, 1989; Margette *et al.*, 1989). Dissolved nutrients, especially nitrate, are readily taken up and assimilated by plants (Yates and Sheridan, 1983; Peterjohn and Correll, 1984; Howard-Williams and Downes, 1984; Howard-Williams *et al.*, 1986; Pinay *et al.*, 1990).

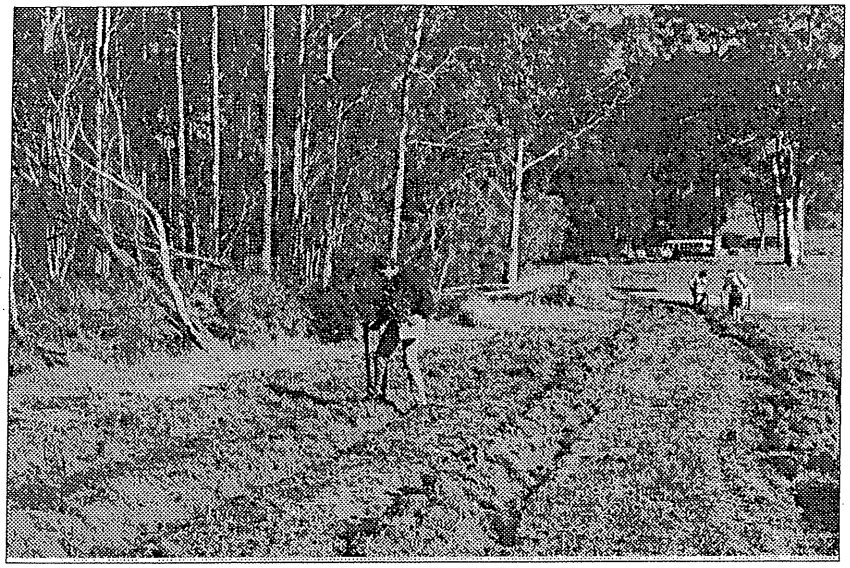
By reducing stream flow, riparian vegetation promotes sediment deposition (Thorne, 1990). Sand can be deposited even when water is fast moving and silt will settle out where vegetation causes a marked reduction in flow. However, near-still water, such as that caught in densely vegetated floodplains, is required for the deposition of the very fine clay fractions (Troeh *et al.*, 1980). Over time, substantial stream bank and floodplain accretion can occur in certain areas as a result of sediment deposition, and this can alter hydrological processes (Thorne, 1990). The removal of suspended sediment by vegetation is especially important, as water carrying sediment has a greater momentum and is more abrasive than clean water, and thus has an enhanced capacity to cause erosion (Troeh, 1980).

Much of the nutrients trapped in the vegetation of waterways or in buffer strips is assimilated by the vegetation (Odum, 1990). Generally, the longer the water is held by the vegetation, the greater the uptake of nutrients (Howard-Williams *et al.*, 1986). Of course, the nutrients are eventually released back into the water column when plant material decays, but much of this will once again be assimilated. In this way the riparian system retards the rate of transfer of nutrient particles downstream, in a process known as nutrient spiralling (Pieczynska, 1990; Pinay *et al.*, 1990).

Nitrogen can be removed from riparian systems completely. This occurs via the biochemical process of denitrification, which causes nitrate to be converted to gaseous nitrogen. This process can be the major form of nitrogen removal in certain riparian zones and during particular environmental conditions such as those which occur during and after flooding (Jacobs and Gilliam, 1985; Pinay *et al.*, 1990).

1.5.3 Ecological values

Streamline vegetation not only has natural resource value in its own right, but it also provides a range of habitats for a large variety of plants and animals, particularly species which are restricted to moist or aquatic environments or species which are restricted to particular rivers or streams. For example, the Little River and its tributaries provides one of the few breeding environments for the Pouched Lamprey (*Geotria australis*). Furthermore, as stream systems are linear in form and cover large distances, their vegetation helps to create ecological corridors. These natural corridors, along with unnatural ones such as the vegetated strips along road and rail reserves, enable plant and animal species to move between larger patches of remnant habitat (Hussey *et al.*, 1989).



*Tree planting in progress on ripped, mounded and sprayed revegetation site next to the Little River, close to the Broken Bridge vineyard site (July 1994). Apace Green Skills and the Denmark Environment Centre established a range of native trees and shrubs on this site, including Karri (*Eucalyptus diversicolor*), Yate (*Eucalyptus cornuta*), Golden Wreath wattle (*Acacia saligna*) and WA Peppermint (*Agonis flexuosa*). Shire of Denmark fencing subsidies were used to assist the landholder with fencing material costs, and trees were provided through Greening Western Australia's Plants for Conservation Program.*

The same site (from a different view), photographed 29 months later, showing successful survival and growth rates. (November 1996).

Tree planting adjacent to Little River in July 1996, coordinated by Apace Green Skills, with assistance from the Shire of Denmark and Wilson Inlet Management Authority. This site provides a buffer between Broken Bridge vineyard and the river. A wide variety of local tree and shrub species, grown at the Shire revegetation nursery, was planted at that time.

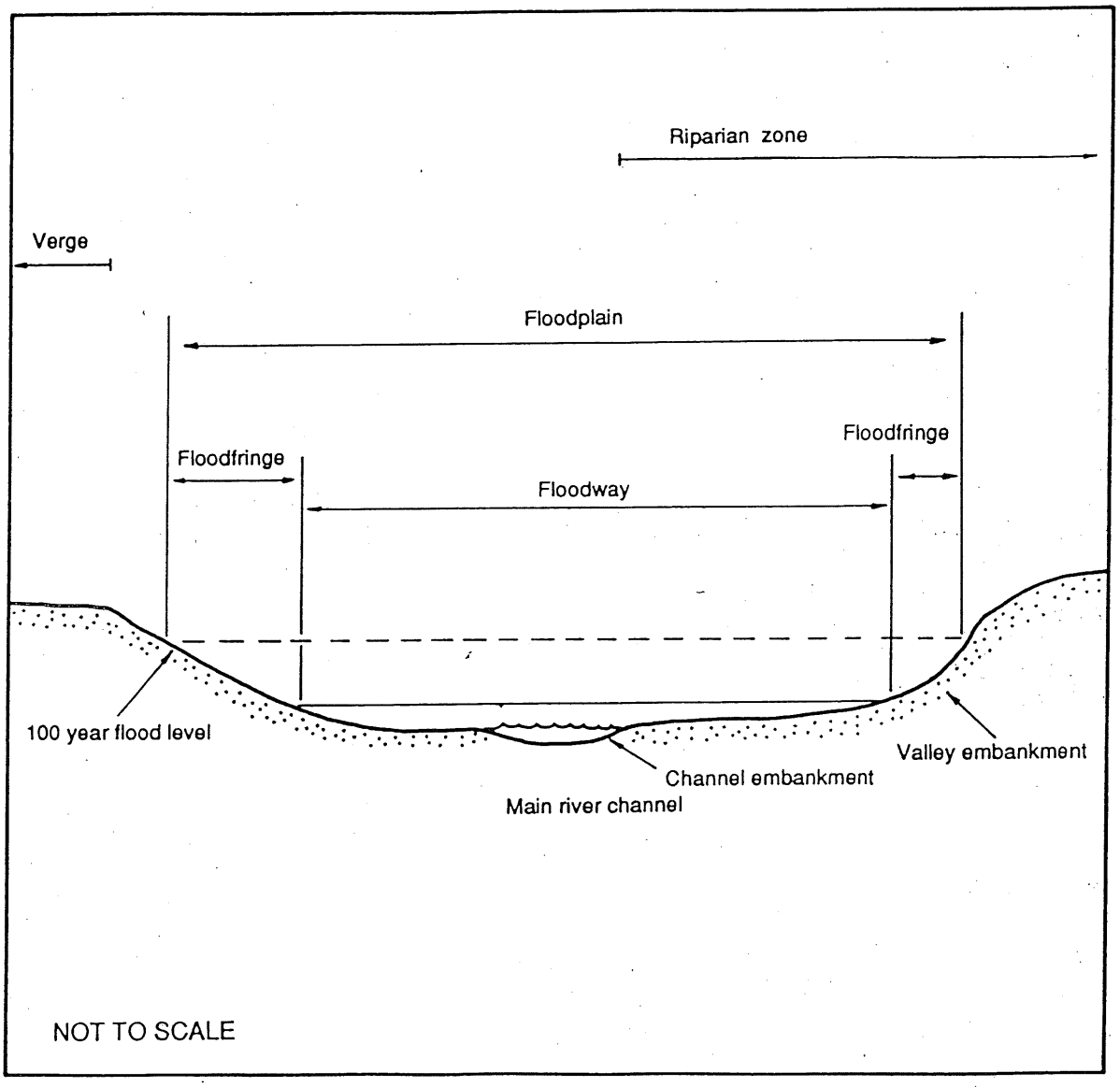


Figure 2.1 - Terms used to describe river valley form.

2. RIVER VALLEY FORM AND THE PROCESS OF RIVER DEGRADATION

2.1 River form

2.1.1 Cross sectional form

Figure 2.1 illustrates typical river valley form in south-west Western Australia and the nomenclature used to describe it.

A typical south-west river consists of a floodway which resides in a valley. Within the floodway, water generally flows along a central channel, which will wander from one side of the floodway to the other as water moves downstream. Sometimes there are two channels: a primary one, which always carries water, and a higher secondary one, which will carry water in times of flood. At times of heavy discharge the entire floodway will carry water. It is during these large floods, when the broad channel or floodway of the river is full of water, that the river establishes and maintains its form, including the pools and riffles (see below).

When the floodway is contained within a shallow or steep valley, the embankments on each side will contain the water from even the most severe flooding and, therefore, the extent of the extra flood fringe is minor. Conversely, when there is no obvious valley form, the floodplain (ie. floodway plus flood fringe) may extend over a very wide area.

Fringing vegetation seldom occupies the main channel but where water movement is very slow, due to the frictional effects of floodplain vegetation or stream debris, some aquatic species are able to take root. On the other hand, the channel embankment and the floodway support dense vegetation, which may extend over a broad floodplain or up the river valley embankments. Floodplain and river valley embankments can support their own distinctive plant communities, which are often more open than those of the floodway.

2.1.2 Channels, riffles and deep pools

Length-wise, the typical south-west river can be divided into three distinct zones. These are the long narrow channels which meander along the floodplain, broad shallow riffle zones and deep broad pools. A typical central channel is often no more than a few metres across, while the floodway can be 5 to 20 metres broad. Sometimes the riffle zones consist of open areas where shallow water passes over stones, while in other areas it can be densely vegetated, with shallow water passing between clumps of sedges and tree stems. For example, it is not uncommon for the river floodway to support a completely closed canopy of paperbark trees, where, in the absence of an understorey, the water passes freely between the tree stems.

Deep pools are dotted along the length of rivers and are formed as a result of the movement of water (Marsh and Dozier, 1981). In south-western Australia these pools are as long as 50 to 500 metres or more and are typically 20 to 50 metres across and from 3 to 9 metres deep. Ecologically they are integral to the south-western Australian river ecosystem, nearly always retaining water over the hot dry summer/autumn months when the channel and riffle zones dry up, thus providing refuge habitat in times of drought for many aquatic animals, including birds, turtles, water rats, fish, crayfish, shrimp and mussels.

2.2 River valley degradation: from river to drain

Previous work by Pen (1994) indicates that there is a pattern of degradation which can be used to describe the state of rivers in south-western Western Australia (see Fig. 3.1).

2.2.1 The healthy river valley

In a healthy river valley, native vegetation is dominant. Not only does it provide habitat for a huge range of animals, but it also supports the substratum that sustains it (Thorne, 1990). The large root systems of trees, which may extend as far as 50 metres, become interlaced and tangled to form a mesh or matrix of roots to a depth of two to three metres or more. This matrix of roots and soil, where trees become tied to each other and support each other, is found right along each side of the river and holds the river valley embankments securely in place. The smaller root systems of shrubs and rhizomes of sedges and the tiny root and rhizome systems of herbs, grasses and small sedges hold the soil firmly in place between the large tree roots and, most importantly, form dense masses of roots and rhizomes along the actual river channel.

In this way, the most powerful floods and heaviest rainfall cannot dislodge the soil of the river valley for virtually the entire length of the river. Only rarely does the action of water gain the upper hand and erosion occur. This usually happens at power bends along the river and would appear, in most cases, to be quickly arrested by the growth of abundant vegetation.

Dense vegetation also serves to retard the rate of flow of floodwaters and to filter out or cause the settling of suspended solids (Thorne, 1990). This action is enhanced by fallen branches which trap leaf litter and cause the formation of obstructions which dam the floodwaters, further reducing their velocity and capacity to erode and carry sediment. In a totally vegetated catchment floodwaters are held back by the frictional and damming effects of fringing vegetation along hundreds if not thousands of kilometres of streamline and much of the energy required to erode and to carry sediment has been dissipated by the time the waters have reached the estuary.

2.2.2 The degrading river valley

The earliest stage of degradation is the occasional presence of weeds. In near pristine vegetation, weeds are probably brought in by the wind or animals. This type of degradation is merely floristic and poses no threat to the integrity of the river valley, as the native vegetation remains dominant. However, where there are points of physical disturbance, such as along walking and vehicular tracks or where feral pigs or rabbits have turned over the soil, localised exposures of soil and infestations of weeds may occur. In this situation there is a small risk of severe water erosion.

Typically, severe degradation does not begin until livestock regularly enters the river valley to graze. Here they trample the native vegetation, eat out the more palatable species, trample the soil and bring in weed seed. This serves to encourage the establishment of weeds and to discourage the regeneration of native species. The longer the river valley is subject to livestock and the heavier the stocking levels, the quicker the native vegetation is replaced by weeds. The rate of weed invasion is accelerated by an increase in the frequency of fires, which favours species with short life cycles, which are mostly introduced grasses, over species with long life cycles, which are mostly native (Hussey and Wallace, 1993).

Eventually, the native understorey species are replaced entirely by weeds and the native trees begin to die out as the level of regeneration can no longer keep pace with mortality.

2.2.3 The eroding river valley

With continued livestock grazing and trampling and frequent fires, the deep root systems of native shrubs, sedges, grasses and herbs, which once had a firm hold on the soil between the large tree roots, are largely replaced by the shallow root systems of introduced annual grasses and other weeds. These new species do not bind the surface soil as well as the former native species, especially over the late summer/autumn period when most have senesced, and are quite easily dislodged by livestock trampling and surface water flow. Under these conditions, the river valley is prone to severe erosion.

If the thin protection afforded by annual weeds is lost the soil between the large roots of trees and tall shrubs is easily washed away. Up on the valley embankment surface flow from adjacent pastured areas or high flood waters can dig long furrows, exposing tree roots and undermining trees and tall shrubs. Lower down, huge bites can be taken out of the river channel embankment and the valley embankment can be undermined, causing further sections to be undercut beneath the root zone and to collapse into the river. Where this occurs, the remaining part of the embankment can be held in place by tree roots until further undercut, but if trees are not present to support the embankment, parts of the embankment can subside into the river. This would appear to occur in very wet weather where unsupported valley embankments become sodden (Thorne, 1990).

At first, only the most prone areas will exhibit severe erosion, but gradually more and more areas will become eroded, until the river resembles a ditch. Not only will the river valley become increasingly prone to erosion as a result of loss of supporting native fringing vegetation, but as it does so the river can become smoother in parts, and the energy which was once dissipated by the vegetation will become available to erode and to carry sediment. There is also less vegetation to intercept the sediment, and thus prevent it from being washed downstream and ultimately into the estuary.

Ironically, coarse sediment lost from the stream banks can build up in places in the stream bed, which becomes wider and shallower as the material of the eroded embankments fills the floodway. In this situation, high bed sediment loads can have two effects: increased bed roughness can retard stream flow and cause upstream flooding; or conversely, large sediment accumulations can deflect flow into the adjacent stream bank or even onto adjacent land, causing further erosion (Schmidt and DeBano, 1990; Thorne, 1990).

The progressive degradation of riparian vegetation has a compounding effect on the waterway, as the reservoir of sediment and nutrients filtered out and assimilated by downstream vegetation over many years begins to be released. This factor could be responsible for the sudden discharge of large quantities of sediment and nutrients into estuaries when parts of this reservoir of material are dislodged by severe floods.

3. MATERIALS AND METHODS

3.1 Vegetation description

Colour aerial photographs at 1:20,000 scale were obtained from the Wilson Inlet Management Authority, Agriculture Western Australia and the Waters and Rivers Commission for the study area, and sketch maps were produced by Watershed Digital Mapping at 1:10,000 scale. The sketch maps were drawn to convey information on property boundaries, river foreshore boundaries, the distribution of vegetation, the river and the land form.

These sketch maps were then taken into the field and annotated with relevant information on landscape, plant communities, weed infestations, foreshore condition, points of severe erosion and fencing status.

The surveys of the Little River and its tributaries took place over a four week period in August 1996. A botanical survey by Mark Parre of six sites along the Little River and its tributaries took place in late July 1996.

3.2 River foreshore condition assessment

3.2.1 System of assessment

The condition of a section of river foreshore or riparian zone was assessed using a simple system developed by Pen (1994) from observations of river system degradation throughout the south-west of Western Australia . The methods, grades and system of assessment have been summarised in Pen and Scott (1995). The system consists of a number of stages or grades - A, B, C and D - beginning at pristine and running through to completely degraded, following the general process of degradation outlined in 2.2. Each grade has three sub-levels which are easy to recognise. This system is described below.

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, including livestock damage (Fig 3.1A). 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 (Fig. 3.1A).

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 (Fig. 3.1A). Otherwise, native plants dominate and would quickly recolonise 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 (Fig. 3.1B). 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 (Fig. 3.1B). 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 (Fig. 3.1B).

C-Grade foreshore

C1. Erosion prone

While trees remain, possibly with some large shrubs or grass trees, the understorey consists entirely of weeds, mainly annual grasses (Fig. 3.1C). Most of the trees will be of only a few resilient or long-lived species and their regeneration will be mostly negligible. In this state, where the soil is supported by short-lived weeds, 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 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 (Fig. 3.1D). Undermined and subsided embankments are common, as are large sediment plumes along the river channel.

D3. Drain - weed dominated

The highly eroded river valley has been fenced off, enabling the colonisation of perennial weeds (Fig. 3.1D). The river has become a simple drain, similar, if not identical, to the typical major urban drain.

3.2.2 Application in the field

A section of foreshore would be recognised for assessment on the basis of general homogeneity. For example, a section of foreshore which was fenced off was assessed separately from an adjacent section that was not fenced off and subject to grazing. The floodway and up to 25 metres up the valley embankment were assessed together. The opposite banks of the river were assessed separately and the maps show separate class boundaries for the right and left banks of the river. The right and left banks are the right and left when facing upstream.

The banks of the tributaries were assessed together and their combined condition recorded.

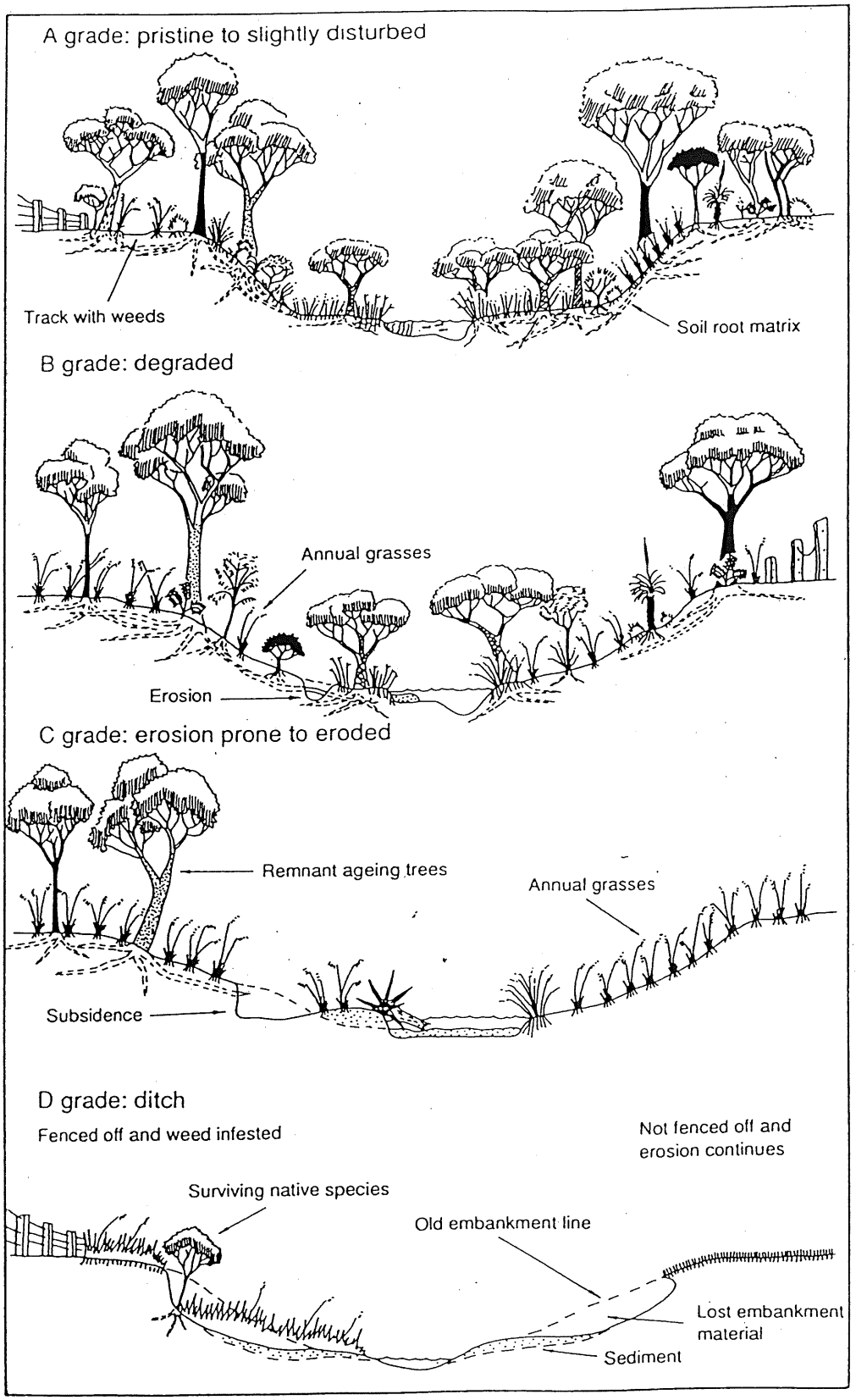


Figure 3.1 - River foreshore condition divided into four stages or grades following the general process of river valley degradation, from pristine river (A) to ditch (D).

4. GENERAL CONDITION OF THE FORESHORES OF THE LITTLE RIVER CATCHMENT

Table 4.1 provides details of the length of the river, the northern tributaries, and the southern tributaries, the length of the river and its tributaries adjoined to farmland, riparian condition, current fencing on farms, recommended fencing and recommended revegetation on farms in the study area.

A total of 48.5 km of the Little River and its tributaries were surveyed. A substantial length of watercourse, mostly in the northern tributaries, falls within public land and has Class A condition foreshores.

The overall on farm watercourse length was 44.17 km. This consisted of a river length of 9.57 km and a tributary length of 34.6km. About 64% of river length, is already fenced and of the tributary length approximately 45% of the northern tributaries and about 34% of the southern tributaries are currently fenced.

Of the total length of river and tributaries approximately 34% of the riparian zone was A grade, 22.5% B grade, 26% C grade and 17.5% D grade. Approximately 57 ha of river and tributary valley embankment and foreshore was identified as requiring vegetation rehabilitation.

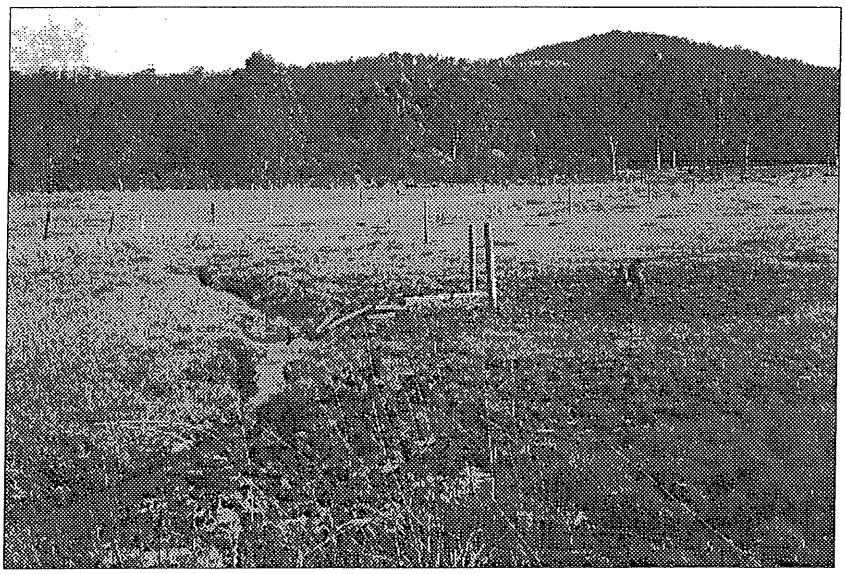
Detailed descriptions of required fencing, vegetation rehabilitation and weed control are provided with maps and tables in Chapter 7.

Category	Water-course Length	Farm Water-course Length	Foreshore condition by percentage (%) ( ) = Adjacent to On Farm Watercourse Length				Farm Length Fenced	Farm Fence Length Required	Vegetation Planting Suggested
	(km)	(km)	A	B	C	D	km %	km	(ha)
Little River	10.41	9.57	21	28	45	5	12.49 64%	10.84	14.65
Northern Tributaries	28.03	24.9	45	18.5	13	23.5	22.28 45%	35.11	26.78
Southern Tributaries	10.07	9.7	20	26	40	14	6.65 34%	13.44	15.83
TOTALS	48.51	44.17	34	22.5	26	17.5	41.42 47%	59.39	57.26
			(27.5)	(24.5)	(29)	(19)			

Note: A substantial length of watercourse, mostly in the northern tributaries, falls within public land and has Class A condition foreshores. The on farm watercourse condition is given in brackets.

Table 4.1. - General condition of the foreshores of watercourses in the Little River catchment

Recently bulldozed watercourse in the Little River catchment, adjacent to South Coast Highway. This action has lead to significant erosion and sediment loss. Protection of this watercourse from stock and natural regeneration of revegetation would be essential to rehabilitate this site.



Fencing in progress on a small tributary of the Little River, close to Ocean Beach Road. In this case, the fence ought be sited further away from the watercourse, in order to allow for several rows of trees and shrubs to be established in the riparian buffer zone.

Little River fenced off with single wire electric fencing. While this does prevent cattle from damaging the riverbanks, the fence needs to be relocated, to allow for several rows of native trees and shrubs to be planted and ensure a properly buffered riparian zone.

5. MAJOR THREATS TO THE FORESHORES OF THE LITTLE RIVER CATCHMENT

Access of livestock into the river valley is a significant cause of soil loss along the Little River and its tributaries in the study area. In some areas, erosion was extensive but moderate, but at watering and crossing points where stock trampling is extreme, erosion is quite severe. This was particularly the case where water draining from adjacent pastures flowed down to the crossing or watering point, causing further erosion. Crossing points which were made at fast flowing sections of the river, where embankments were of the non-cohesive type, also suffered heavy erosion.

5.1 Loss of native riparian vegetation

Along much of the Little River and its tributaries, the fringing vegetation is in transition from forest, woodland or heath, to grassland. Only in areas where the fringing vegetation is backed by substantial remnant bush, or where it has been fenced off for a long period of time, is the integrity of the riparian vegetation secure. Otherwise the native herbs, sedges, shrubs and trees of the rivers are slowly being replaced by introduced annual and perennial grasses and other weeds.

These introduced grasses and other weeds do not create the deep soil-root matrix required to support the river embankment. In the drier regions, the annual grasses or sparsely distributed tussock grasses, such as veldt grass do not even afford adequate superficial protection against water erosion. This means that many kilometres of the river valleys are becoming increasingly prone to erosion.

Furthermore, introduced species do not provide the full range of habitat requirements for native fauna, while still supporting vermin such as rabbits. Riverine aquatic ecosystems depend on native fringing vegetation to provide shade, shelter, leaf litter and debris, and to stabilise pool embankments and riffle zones.

5.2 Breaks in the ecological corridor

The replacement of native plant communities with grasslands represents breaks in the ecological corridor. Some areas of embankment and floodway are devoid of native vegetation. These breaks not only retard the movements of mammals and birds, but fish are reluctant to move into open sunlit areas of water where they are prone to predation and heat stress (Olsen and Skitmore, 1991).

5.3 Erosion and siltation

From fence to fence, the land given over to the river is often only a few metres wide, which means that undercutting and subsidence can eventually bring the river back to the fenceline and eventually beyond it.

5.4 Major weed invasion

With respect to river management, major weed species are those which cannot be controlled by simply eliminating the disturbance regimes which facilitate the establishment and regeneration of common weeds. Major weeds can become established in relatively undisturbed vegetation and soon proliferate to become dominant species, even replacing the tall native trees in time. Examples of weeds include the giant grasses, pampas grass (*Cortaderia selloana*) and giant reed (*Arundo donax*), the vines and creepers morning glory (*Ipomoea indica*) and dolichos pea (*Dipogon lignosus*), and the climbing shrub blackberry brambles (*Rubus spp.*). These species, and many more,

infest large sections of the moist humid river valleys near Perth, Mandurah and Bunbury (Pen, 1992, 1993; Siemon *et al.*, 1993).

The banks of the Little River and its tributaries are generally free from major weed invasions.

However, some outbreaks of serious weed species occur in relatively undisturbed bushland. If left unchecked, these plants will spread and dominate the indigenous species.

Pasture plants have replaced native vegetation in many areas. These plants may not be weeds in the agricultural sense, but they do not perform the functions that native vegetation does. Being shallow-rooted, they leave the soil prone to erosion. their low height provides no shade or shelter for native birds, animals or fish.

Weeds Identified in Survey of Little River conducted by D.Harwood in August 1996

The following weed species were identified in surveying the Little River:

- Arum lily - *Zantedeschia aethiopica*
- Blackberry - *Rubus spp.*
- Blackberry nightshade - *Solanum nigrum*
- Coral tree - *Erythrina*
- Garden fern
- Inkweed - *Phytolacca octandra*
- Oxalis - *Oxalis caprina*
- Sweet Pittosporum - *Pittosporum undulatum*
- Sydney golden wattle - *Acacia longifolia*
- Taylorina - *Psoralea pinnata*
- Tree fern - *Cyathea sp.*
- Watsonia - *Watsonia spp.*

In addition, potentially serious water cress infestations *(Rorippa nasturtium-aquaticum)* were located obscuring the watercourse channel south of Myers Road (MacKenzie, 1996: 4).

Advice on the treatment of foreshore areas for weeds is provided in Section 6.4.1.

6. REHABILITATION

6.1 Little River

The foreshores of the Little River and its tributaries, which have existing stock grazing as an adjacent landuse, should be fenced off to protect the fringing vegetation of the river valleys from the effects of livestock grazing and trampling, and to prevent the slow degradation of riparian vegetation. Further, all foreshores already degraded need vegetation rehabilitation. Protecting and reinstating the vegetation will maximise the natural bio-filtering and energy dissipation function of riparian vegetation, which is needed to remove nutrients and sediment entering the river via tributary creeks and directly from farmland and to prevent foreshore erosion.

It is worth noting that it will not be sufficient to fence and rehabilitate only the foreshores of the main rivers of the Wilson Inlet catchment. These represent a minor proportion (<5%) of the waterway length. The remaining minor waterways will continue to delivery nutrients and sediment to the main river channels, which will remove some of this material. The main river channel cannot perform all the necessary buffering to reduce nutrient and sediment loss. Nutrient and sediment loss should thus also be tackled on farms, and on the first and second order streams if the values of Wilson Inlet and the main rivers are to be retained and enhanced (Weaver and Prout, 1993).

While fencing off or reinstating vegetation on any of the unprotected parts of the rivers will be beneficial, there are areas which require fencing and/or vegetation rehabilitation more urgently than others. Furthermore, as farmers' funds and subsidies from Government and community groups to construct fences and/or rehabilitate vegetation are limited, it is necessary that these needs are prioritised.

There are four levels of priority (as used in Apace Green Skills and Pen, 1995), which are explained below:

Priority 1- Urgent:

Areas exhibiting severe erosion and/or stock damage which threatens to get worse in the short term.

Priority 1:

Areas showing either limited erosion or the first signs of erosion, or which are prone to erosion due to the absence of fringing vegetation, or areas having infestations of declared weeds (eg. Blackberry).

Priority 2:

Areas which retain substantial fringing vegetation which is becoming progressively degraded by livestock or significant weed infestations (eg. Watsonia).

Priority 3:

Areas which have healthy fringing vegetation or moderately degraded vegetation which are being degraded at a relatively slow rate and are therefore unlikely to become significantly further degraded in the short term.

Most of the foreshores of the Little River catchment fit into the Priority 1 - urgent and Priority 1 categories.

6.2 Placement of fences

Ideally, fences should be placed above the river valley (see Fig. 9.1). Depending on the steepness of the embankment, the fence should be placed 5m to 20m back from the edge of the river valley (Fig. 9.1A). 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 embankments to the adjacent, land and

thereby prevent subsidence. It should be mentioned that while parts of the Little River and its tributaries are fenced off, a number of fences are inappropriately placed to provide maximum support against subsidence.

In the case of shallow river valleys, there is little chance that embankments will subside. Nevertheless, fencelines should be located above the river valley (Fig. 6.1B). 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 be fenced off (see Fig. 6.1C). Some of these fencelines will be prone to flood damage, but this can be minimised if fences run, as much as possible, parallel to the direction of floodwaters.

6.3 Types of fences

Needless to say, fencing should be appropriate to the livestock being grazed. In some cases this means purchasing expensive materials and much time-consuming effort. But fencing along a river need not be too expensive, especially if electric fences are used. Some farmers have found that a single strand of 'hot' wire nailed from tree to tree is effective in keeping stock out of the river. While this is an excellent idea there are a number difficulties which require attention. Firstly, the nail used to attach the wire will wound the tree and open it to infection and, gradually, the tree will grow around and over the nail. A better idea is to tie the wire to the tree and to loosen the tie as the tree grows.

A problem along the Little River and its tributaries is that, in many areas, remaining trees suitable for holding hot wires are too close to the main channel.

6.4 Vegetation rehabilitation

The general subject of vegetation rehabilitation on cleared land is beyond the scope of this report and the reader is referred to the excellent publications listed in Appendix 2.

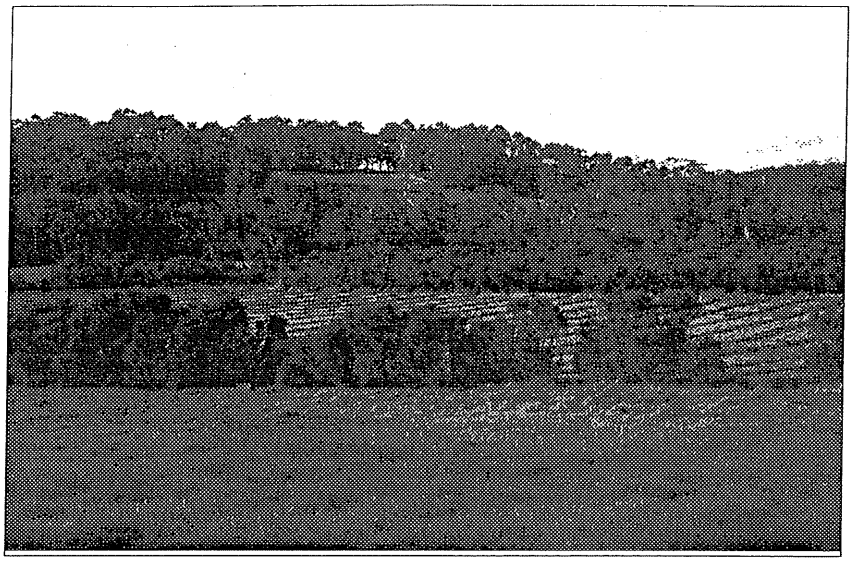
6.4.1 Weed management

Mechanical control of weeds, either by grubbing out or slashing will be possible for the small areas of weeks. If the area weeded is too large to be re-colonised by native regeneration, direct-seeding and/or planting of local indigenous species will be necessary. Mulch in the form of brushing sourced from local indigenous plants can be of assistance in holding the ground and preventing weed regrowth.

Chemical control—using the preparation Roundup Bi-active, which is specially formulated for wetland areas—may be necessary in areas where mechanical control is not possible.

Timing is crucial to the successful eradication of weeds. Control work should generally be carried out before seed set. If mature seeds are present, care must be taken not to disperse them into clean areas. Monitoring to assess the need for follow-up weeding is also of utmost importance.

In all weed control work, care should be taken to minimise disturbance. Erosion, and or further weed growth can occur if large sections of weeds are removed without subsequent seeding or planting with suitable species (See Appendix 1 for plant list).



Site preparation for plantation establishment beside the Little River, on a property on Wentworth Road. Planting took place in June 1994. A range of potential sawlog eucalypt species was planted on this site.

The site, (from a slightly different view), two years later, showing successful establishment and rapid growth rates. Photograph taken in July 1996.

*View over the Little River valley. Little River has been fenced off along the portion visible in this photograph. However, revegetation between the fence and remnant fringing vegetation has been with Tasmanian Blue Gums. It would have been much more preferable for Karri (*Eucalyptus diversicolor*) and other local species to have been planted, in order to enhance the corridor and habitat values of the Little River riparian zone.*

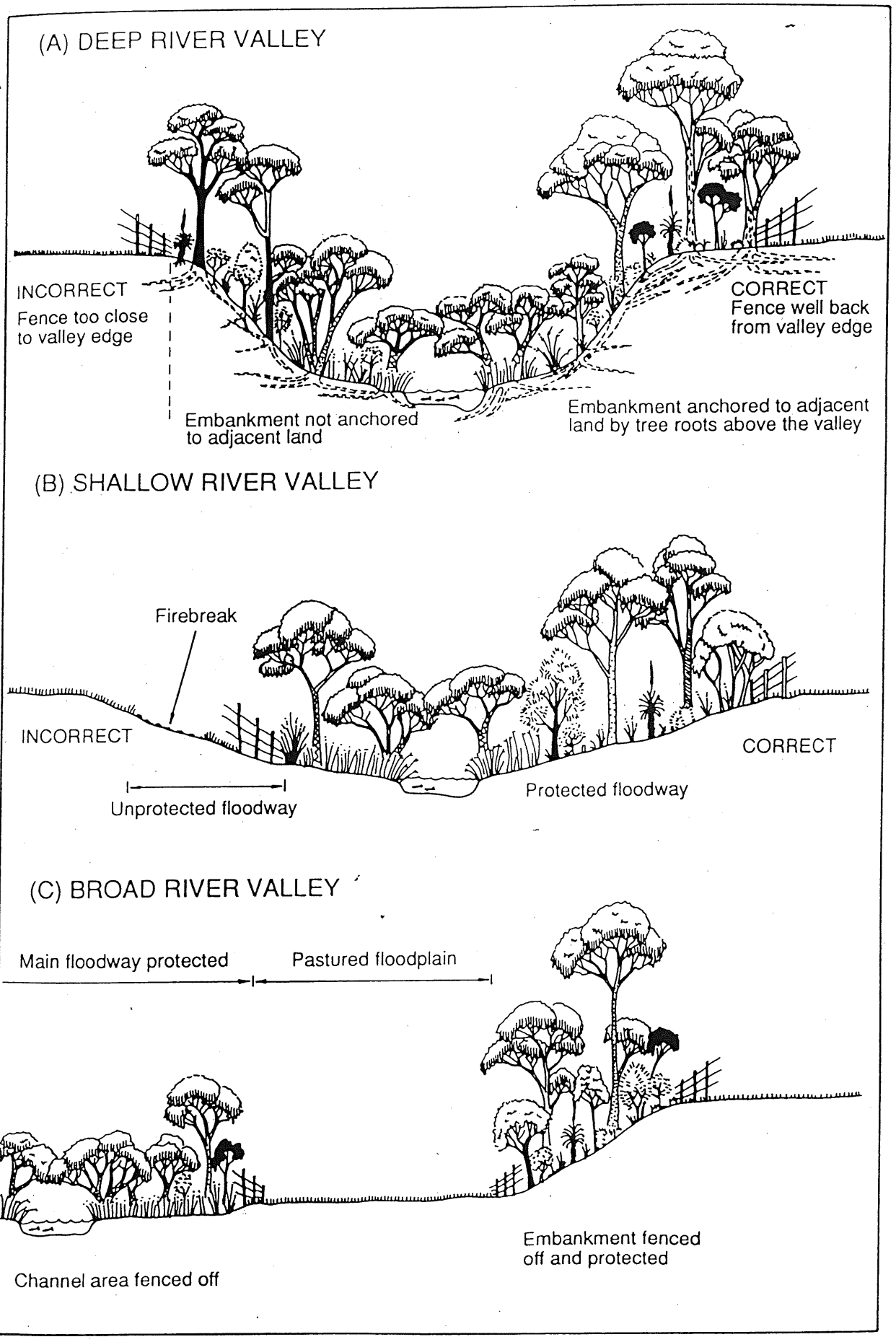


Figure 6.1 - The correct placement of fences in relation to the river valley: (A) the deep river valley, (B) the shallow river valley and (C) the broad river valley with broad floodplain.

6.4.2 Specific site assessment and recommendations

1. Little River from the Inlet to Ocean Beach Road

The native vegetation on both the north and south banks is in excellent condition, although some unauthorised clearing has occurred and the following weed species are beginning to spread.

Sweet pittosporum and Sydney golden wattle. - both of these tree species, which are native to NSW, seed freely and form dense thickets. Control can be achieved by lopping the mature specimens and immediately painting the stumps with undiluted Glyphosate. The cut material should be removed from the site both for aesthetics, and to avoid the build-up of fuel. Seedlings up to two metres tall can be removed manually. Monitoring every two years for seedlings is necessary.

Garden Fern - these small infestations can be removed by hand. Care should be taken to replace mulch and leaf litter.

Watsonia - control by spraying with Round-up Bi-active before flower spike emergence. Although this formula is designed to be used in wetlands, care should be exercised to prevent spray drift, which may damage nearby native plants. Isolated plants may be removed by hand. Flower stalks bearing aerial corms or seeds should be cut and bagged and removed from the site.

Blackberry - these plants have had some control work done, but follow-up work is needed. Treat regrowth with Round-up Bi-active from flowering time to fruit maturity. Small infestations can also be removed by hand.

Blackberry Nightshade - hand pull small populations, or treat with Round-up Bi-active from flowering to berry stage.

Public land between the shores of the Inlet, the river and private property has been regularly mown for some years. Whilst this does reduce the fire hazard, it has also reduced the strip of riverine vegetation to a width of one metre for a distance of 200 metres upstream from the Inlet. Some replanting is required, but this should be done in consultation with the neighbouring residents and the Fire Brigade.

An area below Karri Bay Estate has been cleared to the water's edge, possibly in an attempt to control blackberries. All vegetation ha been removed and the site replanted with exotic garden plants. Non-endemic eucalypts have also been planted on the foreshore. Rehabilitation with local species should be carried out. Education is essential to advise residents of the need to retain a buffer of native vegetation.

2. Little River from Ocean Beach Road North West for 500 Metres

Sweet pittosporum - treat as above.

Watsonia - treat as above.

Arum lily - spot spray with Glyphosate Bi-active from June to October. Monitor for regrowth.

3. Tributary from the North Parallel with Ocean Beach Road

This site was burned in 1995. Natives are regenerating vigorously.

Taylorina - is spreading at the northern edge of the burnt areas. Mature trees can be lopped well below the lower branches. Coppicing will not occur. Seedlings can be removed by hand. Monitor annually for seedlings.

Tree fern - remove mature trees by hand. Check area for juveniles. Monitor annually for regrowth.

Watsonia - treat as above.

4. Tributary Flowing South the East of Sunrise Road Site South of the Highway (Reserve # 19543 and 18716).

This is an old tip site which extends to the water's edge. It is also a current storage area for materials for Main Roads Western Australia. Native vegetation is in good condition.

Oxalis on this site could be controlled by heavy mulching with material derived from local species, such as that used on MRWA road verge rehabilitation.

Blackberry, inkweed and kikuyu in MRWA storage site should be controlled by application of Roundup during active growth.

5. Bridge on old railway line to the East of Wentworth Road.

Coral tree - inject full strength Glyphosate when actively growing.

More specific advice on the rehabilitation of cleared areas is beyond the scope of this report and may be obtained from publications such as 'Managing your Bushland' (Hussey and Wallace, 1996) and Bush Regeneration (Buchanan, 1989).

6.4.3 Planting along the river valley

Areas of exposed river embankment need to be planted to control erosion, by supporting the soil and by dissipating the energy of floodwaters. Actual sites of erosion cannot be planted until they are stabilised, as plantings would easily be washed away in the first winter. However, plantings can be carried out just upstream, on cleared non-eroded embankment, to retard flow rates and encourage sedimentation in the former erosion sites, which, in turn, will create sites which can be planted or will be recolonised naturally by plants.

Vegetation rehabilitation requirements along the Little River and its tributaries are given in the tables and maps in Chapter 7.

6.4.4 Minor useful work

There is much useful work that can be done to accelerate regeneration of native riparian vegetation in those B grade areas of the rivers which have recently been fenced off. Tree and shrub seedlings can be protected from rabbit grazing by placing wire cages or old tyres around them, until the plants are large enough to fend for themselves. The cages or tyres can then be moved to other young plants. On a larger scale, small areas can be surrounded by enclosures to reduce grazing by rabbits and small marsupials. This method produces spectacular results on Rottnest Island where Quokka grazing is a major problem. Even clearing or spraying weeds around young plants will encourage growth.

The ground can be prepared below trees and tall shrubs to encourage seed germination and early growth can be encouraged by spraying weeds and by scarifying (shallow ripping) the soil. Deep ripping is not recommended within 20m of trees as it could damage root systems essential for the stability of the embankment and the trees themselves. Scarification has been observed by the authors to produce good results along the Brunswick and Collie rivers. It should not be done in areas subject to swift flood waters, as severe washouts may result.

Even though these suggested activities are on a small scale, taken across the whole river over many years, they will make a very useful contribution to river protection.

Little river, with its narrow belt of fringing vegetation, and a small tributary, at the point where the river flows into a privately-owned bush block, adjacent to Ocean beach Road. This block performs a valuable bio-filter role.

A cattle crossover point on Little River, near Lights Road. Such points can be sources of erosion if not well stabilised with gravel and, where necessary, with rock.

A drain from a culvert off South Coast Highway, in the vicinity of the Lights Road overtaking lane. Such drains need to be stabilised with native revegetation and, where necessary, with riffle and pool zones.

6.5 Stock crossings and watering points

Where properties cross the river, or where farmers own or manage both sides of the river, livestock crossings are required. The heavy livestock trampling associated with crossings often exposes the soil and initiates serious water erosion. However, simple river crossings, if located and managed properly, need not present an erosion hazard to the river banks. For example, a crossing point could be located just downstream of dense riparian vegetation, where flow rate, even during floods, is minimal, or it could be located in a stony area where erosion is not possible.

In areas where the soil is not cohesive and easily washed away, which is more typical of the Little River and its tributaries, stones can be placed along the track to dissipate energy and buffer the soil against livestock trampling. At the embankments, where the soil is often worn down by livestock, large stones or logs can be placed over small ones to form revetments. Ideally, crossing points should be fenced off when not in use, to prevent livestock access to the river valley.

Because crossings run up and down the river valley embankments they are prone to erosion by water running off the paddocks and channelling down the tracks. To prevent this, tracks leading down to crossing points should not be aligned with the natural drainage lines of the adjacent paddocks.

6.6 Plant species for rehabilitation

Long term general rehabilitation of parts of the fringing vegetation of the Little River and its tributaries will be necessary to maintain the habitat, bio-filter and ecological corridor functions of the rivers, to combat erosion and preserve the riverine landscape of the region. Lists of native plant species likely to be suitable for the Little River and its tributaries are given in Appendix 1. This Appendix presents information gained from a botanical survey carried out by Mark Parre for this report and from Tables 1 and 2 from Janicke (1994). *An Inventory of plant species found at six locations along the Denmark and Hay Rivers.* A report prepared for the Wilson Inlet Management Authority and South Coast Estuaries Project.

7. DETAILED DESCRIPTION OF THE CONDITION AND REHABILITATION NEEDS OF THE LITTLE RIVER CATCHMENT

The Little River Catchment is divided into twenty two maps (Maps 1-22). Map 1.2 shows the layout of the map numbering of the river and tributaries. For each map a corresponding table has been developed on which the foreshore condition along with fencing, vegetation rehabilitation, revegetation needs and erosion and weed control needs are recorded.

Please note the following:

- To allow ease of reading from one map to the next, each map has been printed with an overlap. The data and information in the table opposite each map refers only to the area indicated, and does not include the overlap.
- Class boundaries on all tributaries although not shown, start at their junction with Little River.

Information provided in these Forms and Maps are intended only as advisory recommendations to landholders and agencies. Because of changing landuse in the catchment, all recommended fencing is made on the assumption that livestock are being or will be grazed in the area. Obviously this is not always the case, and thus when interpreting the maps and recommendations, landholders need to take into account management and landuse practices they have in place for their properties. Landholders are encouraged to apply for fencing and other possible assistance from the Wilson Inlet Management Authority if they are willing to assist with waterways improvement.

Landholders noting any mistake or modification required of any of these maps are encouraged to provide this information to the Denmark Environment Centre or the Wilson Inlet Management Authority.

LITTLE RIVER SURVEY- Map 1 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: 552, 554, 553.
Survey Project Officer: Alex Syme
Date: August 1996

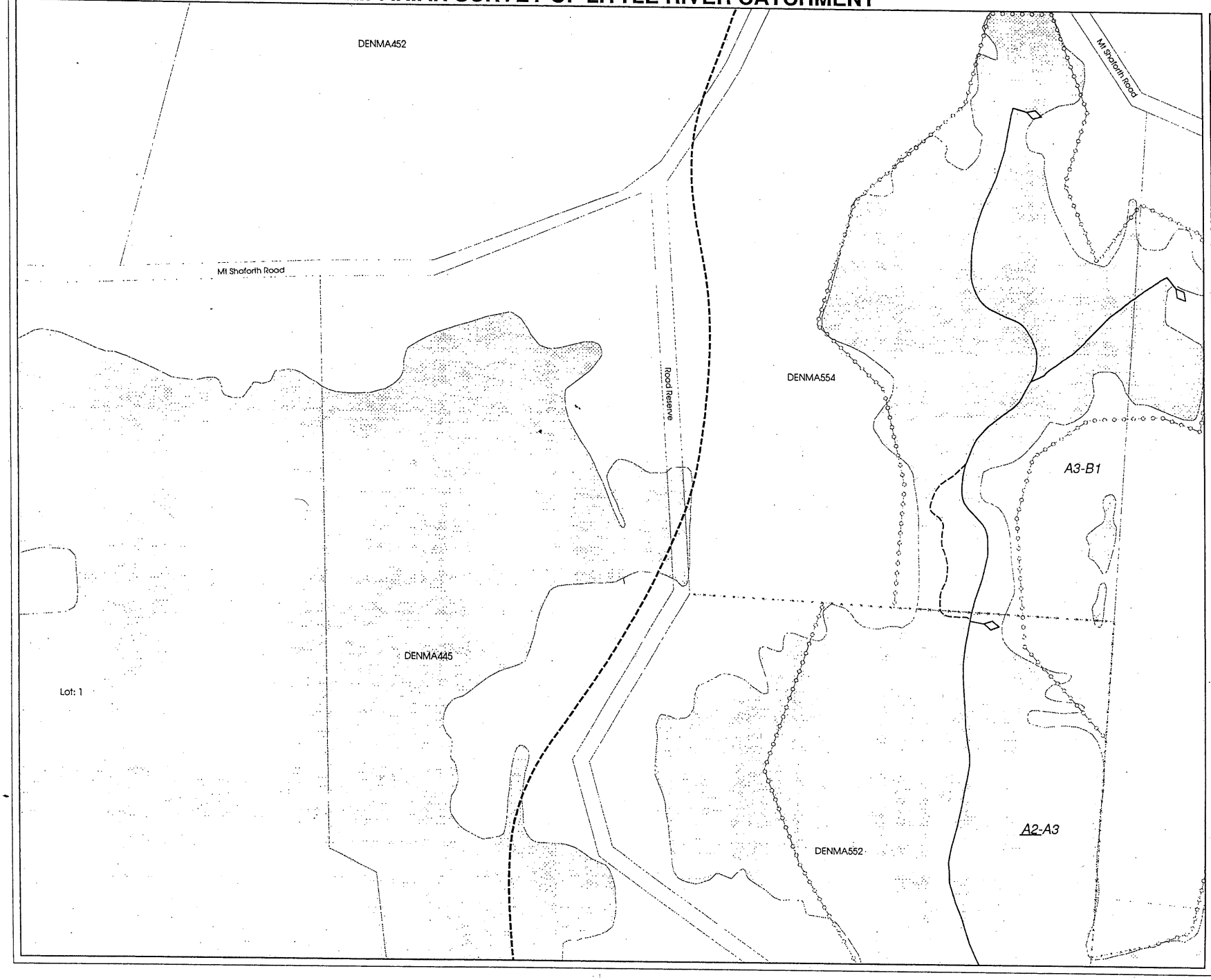
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	1,050 Metres
Length of watercourse Fencing Recommended	N/A	2,775 Metres
Number of severe erosion sites	N/A	Nil
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: N/A
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): Nil
Advice on Revegetation Species and Preparation	N/A	N/A
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	Nil
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: N/A
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 1



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 2 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: 908, 699, 551.
Survey Project Officer: Alex Syme
Date: August 1996

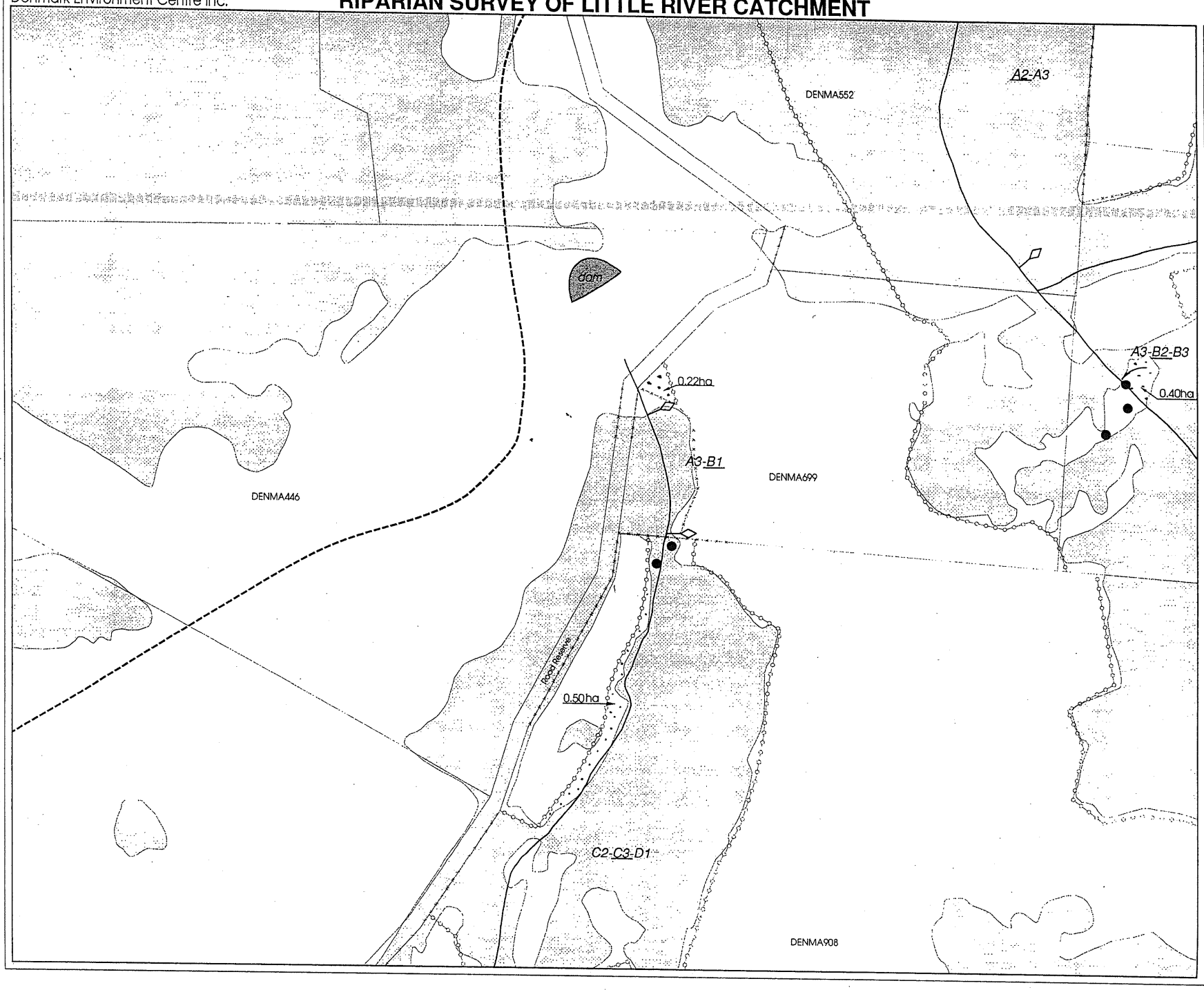
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	1,225 Metres
Length of watercourse Fencing Recommended	N/A	2,475 Metres
Number of severe erosion sites	N/A	4
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: Exclude stock from frequent use of crossing points. Brush, hand plant, allow natural regeneration.
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): 1.2
Advice on Revegetation Species and Preparation	N/A	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens.* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	Nil
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: N/A
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 2



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 3 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: 2628, 5911, 2624, Lot 908.
Survey Project Officer: Alex Syme
Date: August 1996

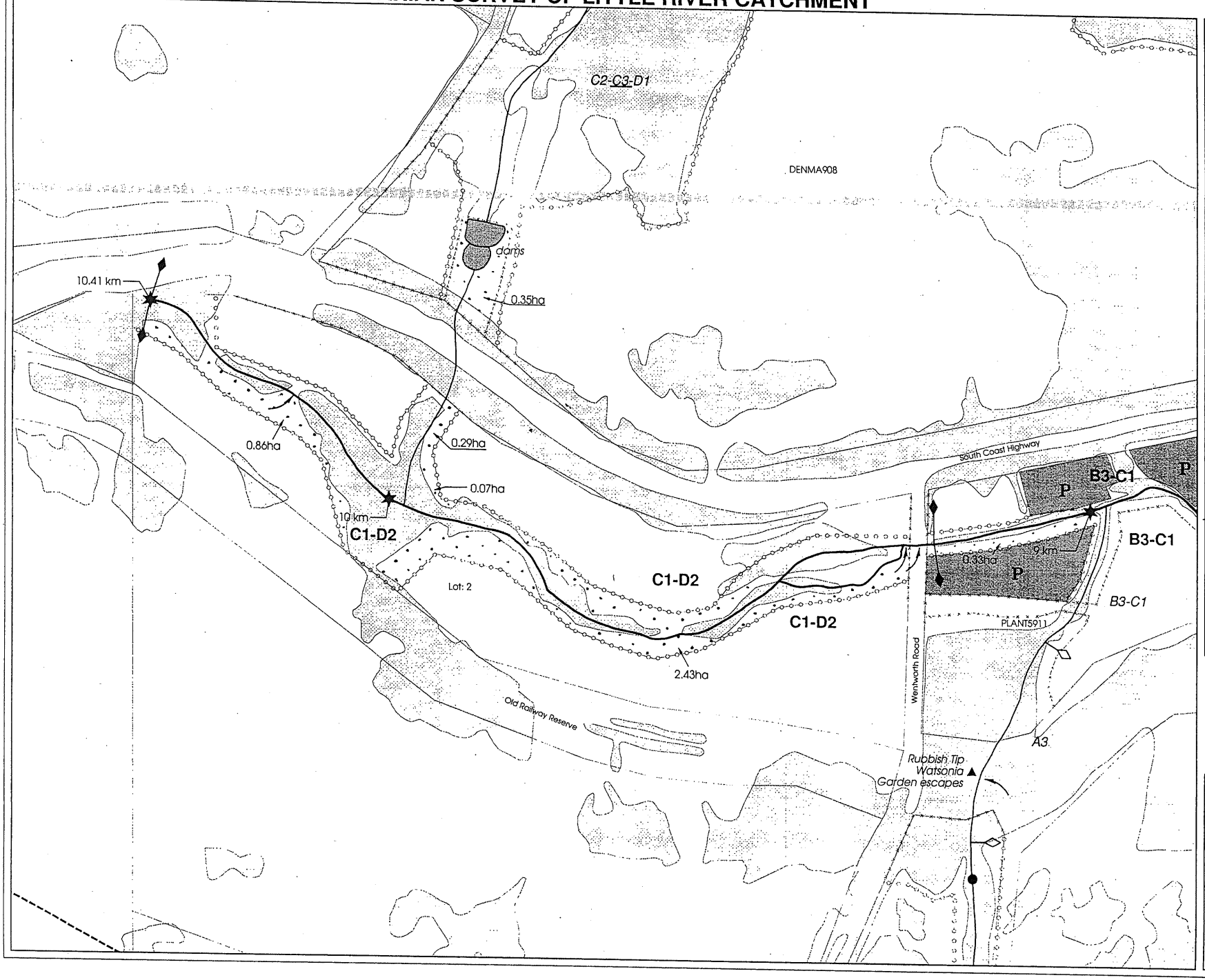
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	450 Metres	1,825 Metres
Length of watercourse Fencing Recommended	2,500 Metres	1,525 Metres
Number of severe erosion sites	Nil	1
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: Exclude stock from frequent use of crossing points. Brush, hand plant.
Approximate area along watercourse requiring revegetation work	Area (Ha.): 3.7	Area (Ha.): 1.2
Advice on Revegetation Species and Preparation	Hand plant *Agonis juniperina, E. diversicolor, Eucalyptus calophylla , Eucalyptus patens, Eucalyptus megacarpa, Melaleuca rhaphiophylla , Agonis hypericifolia .* (Select further species from Appendix 1)	Hand plant *Agonis juniperina, E. diversicolor, Eucalyptus calophylla , Eucalyptus patens, Eucalyptus megacarpa, Melaleuca rhaphiophylla , Agonis hypericifolia .* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	Nil	1
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: Treat weeds and allow natural revegetation.
Other Management Related Information for this map		

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 3



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 4 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: 2628
Survey Project Officer: Alex Syme
Date: August 1996

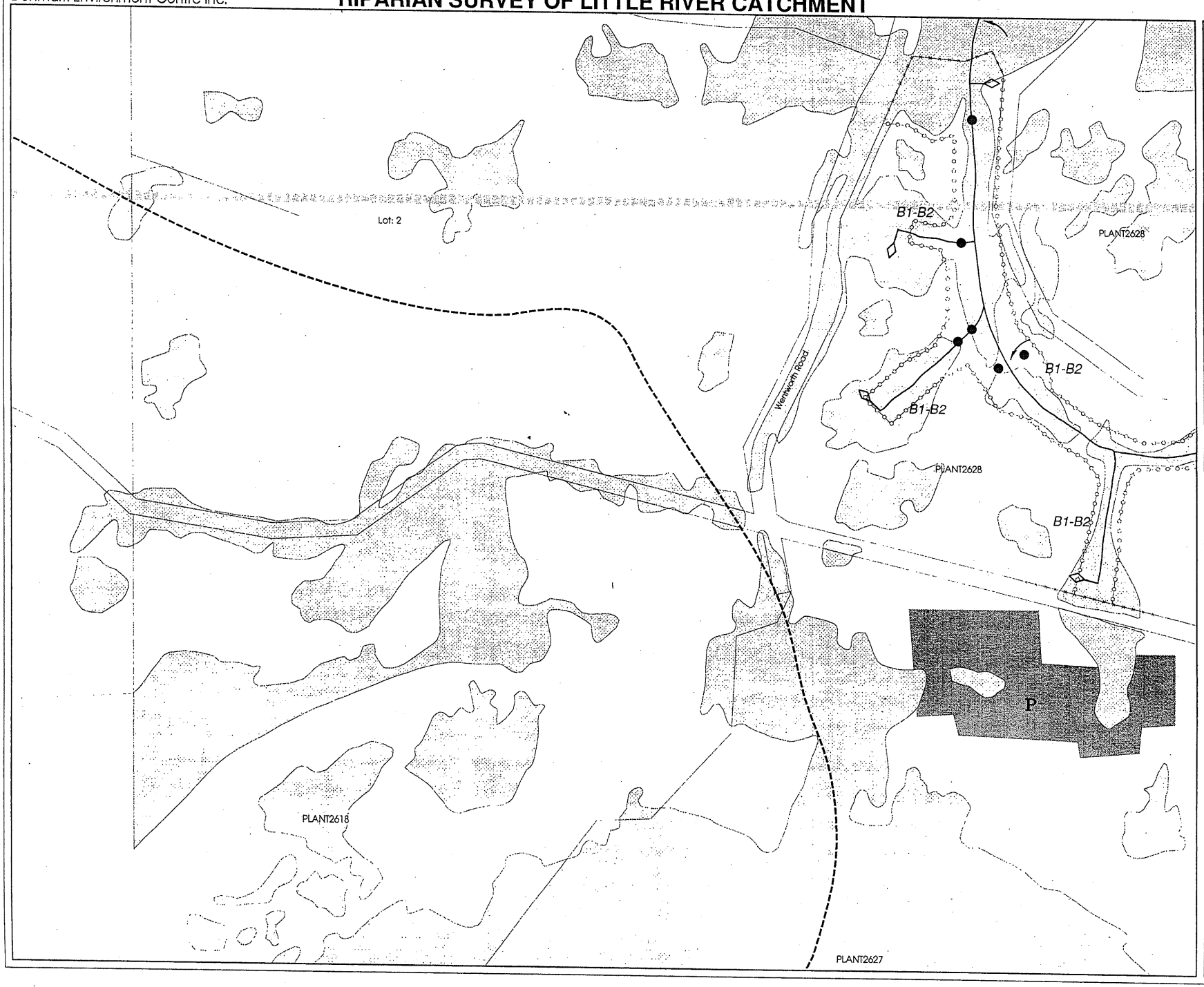
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	225 Metres
Length of watercourse Fencing Recommended	N/A	1,475 metres
Number of severe erosion sites	N/A	5
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: Exclude stock from frequent use of crossing points. Brush, hand plant, allow natural regeneration.
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): Nil
Advice on Revegetation Species and Preparation	N/A	N/A
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	Nil
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: N/A
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 4



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* Serious weed infestation and species
- 1.30 ha Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 5. See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: Loc. 717, 440, 834, 551, 553.
Survey Project Officer: Alex Syme
Date: August 1996

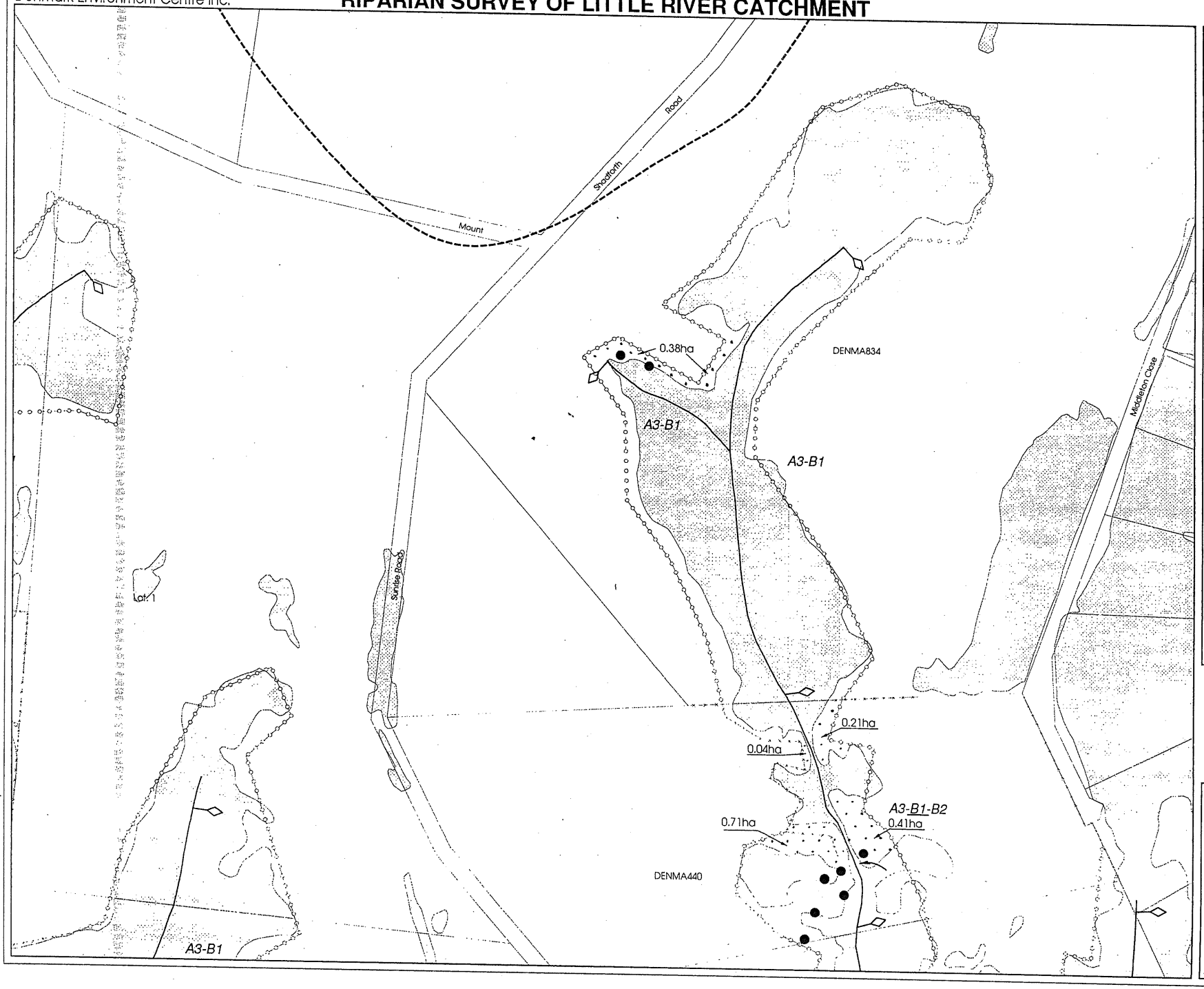
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	750 Metres
Length of watercourse Fencing Recommended	N/A	4,050 Metres
Number of severe erosion sites	N/A	8
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: Exclude stock from frequent use of crossing point. Fence, brush, hand plant.
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): 1.8
Advice on Revegetation Species and Preparation	N/A	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens.* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	Nil
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: N/A
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 5



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 6. See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: Loc. 408, 410, 717, 550, 908, 551.
Survey Project Officer: Alex Syme
Date: August 1996

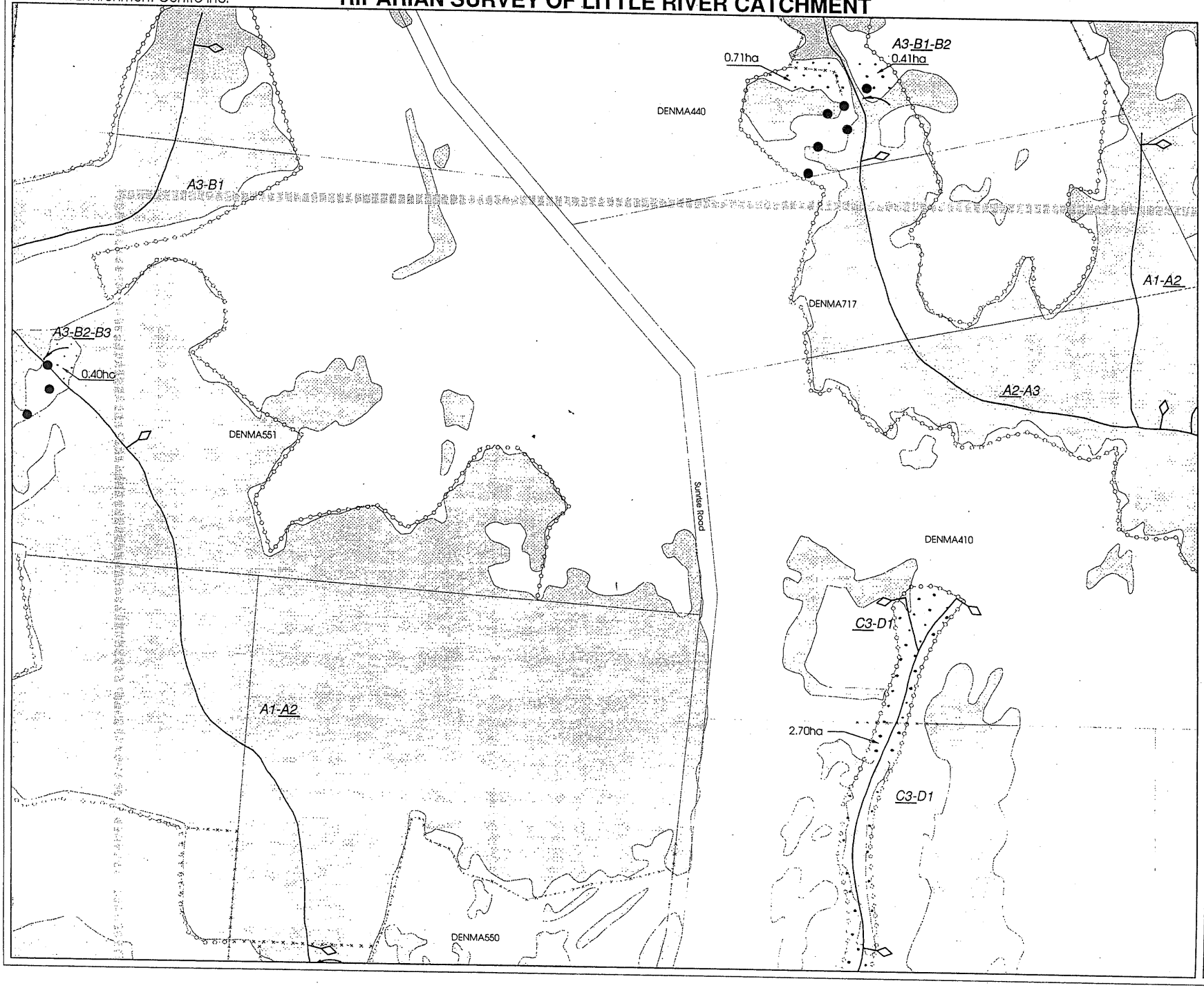
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	1,225 Metres
Length of watercourse Fencing Recommended	N/A	2750 Metres
Number of severe erosion sites	N/A	Nil
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: N/A
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): 1.7
Advice on Revegetation Species and Preparation	N/A	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus marginata* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	Nil
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: N/A
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 6



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

n

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
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Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 7 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: Loc. 408, 550, 666, 585, 5911, Res. 18716, 19543.
Survey Project Officer: Alex Syme
Date: August 1996

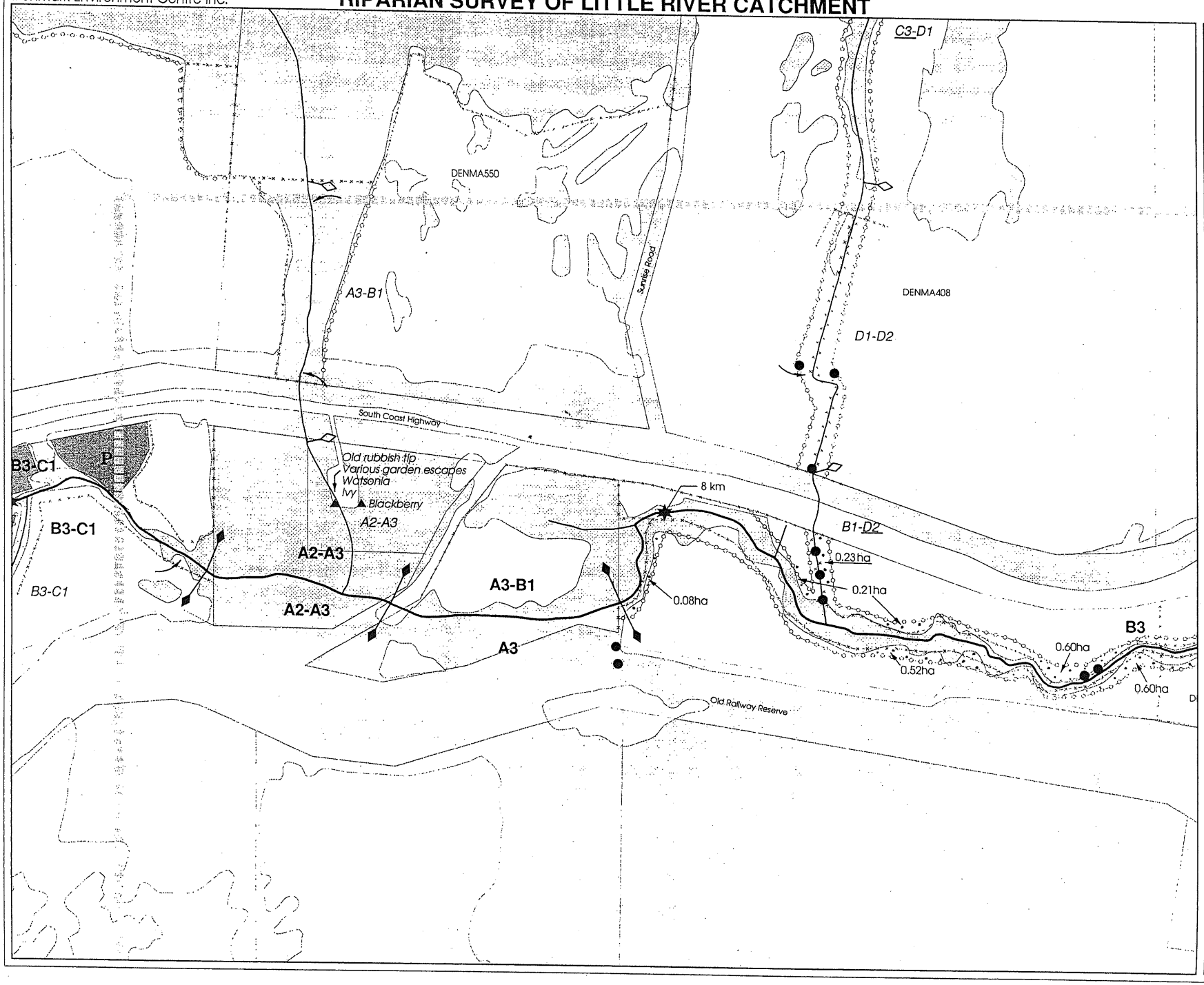
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	2,800 Metres	1,475 Metres
Length of watercourse Fencing Recommended	2,450 Metres Comment: Includes relocating some existing fence further out from channel.	2,100 Metres
Number of severe erosion sites	2	7
Advice on remedial measures required for these sites	Recommendation: Exclude stock from frequent use of crossing points. Brush, hand plant.	Recommendation: Exclude stock from frequent use of crossing points. Brush, hand plant.
Approximate area along watercourse requiring revegetation work	Area (Ha.): 2	Area (Ha.): 1.9
Advice on Revegetation Species and Preparation	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens Eucalyptus marginata* (Select further species from Appendix 1)	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus marginata* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	Nil	1
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: Treat and revegetate
Other Management Related Information for this map		Weed invasion, all garden escapes need urgent attention to prevent further spread.

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 7



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* Serious weed infestation and species
- 1.30 ha Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

n

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
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Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

Loc. Numbers of Adjacent Properties: 2628, 4326.
Survey Project Officer: Alex Syme
Date: August 1996

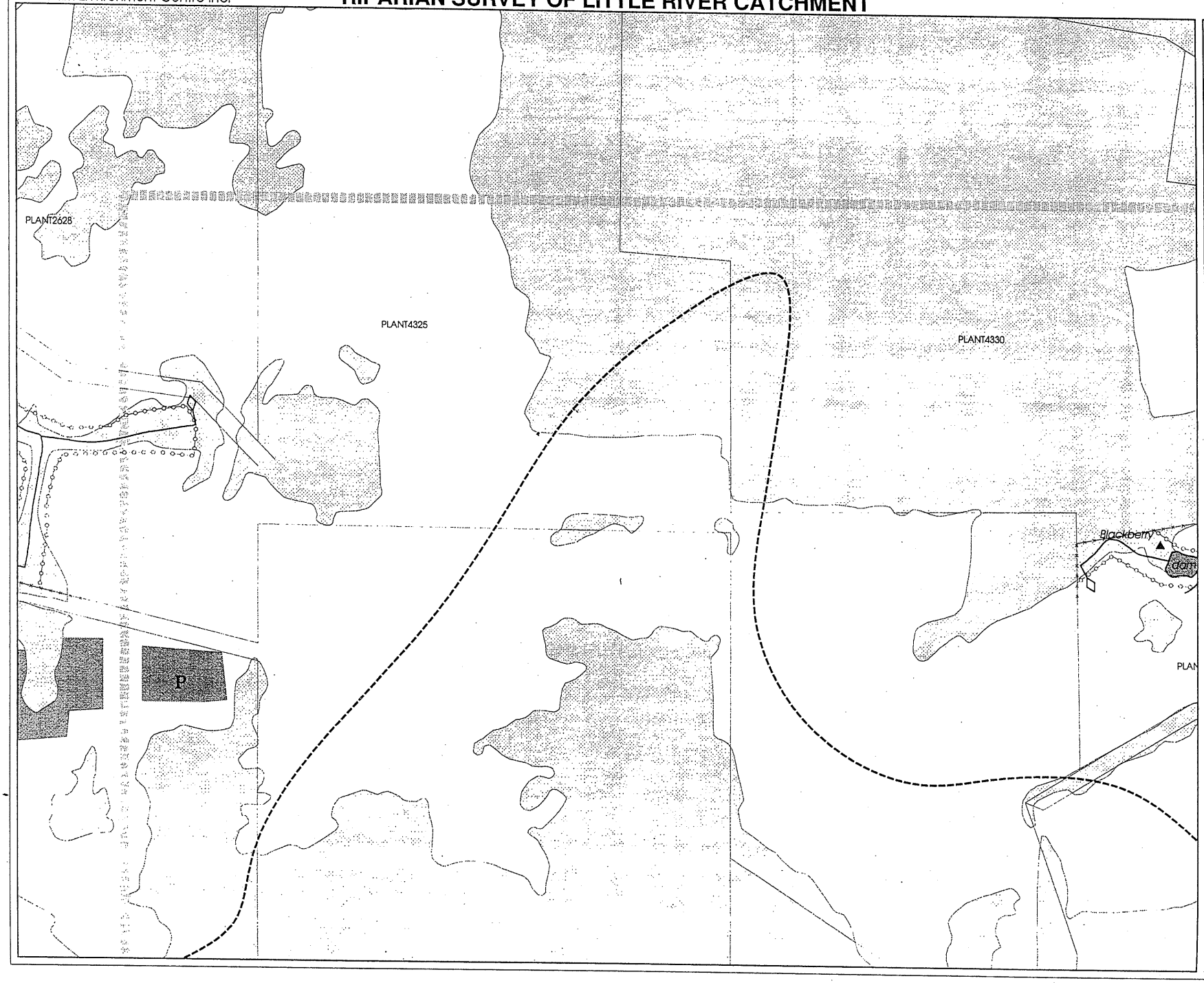
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	250 Metres
Length of watercourse Fencing Recommended	N/A	400 Metres
Number of severe erosion sites	N/A	Nil
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: N/A
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): Nil
Advice on Revegetation Species and Preparation	N/A	N/A
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	2
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: Treat blackberry, allow natural regeneration.
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 8



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- P — Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 9 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: Res. 18340, Loc. 439, Lot 1 of Loc.420.
Survey Project Officer: Alex Syme
Date: August 1996

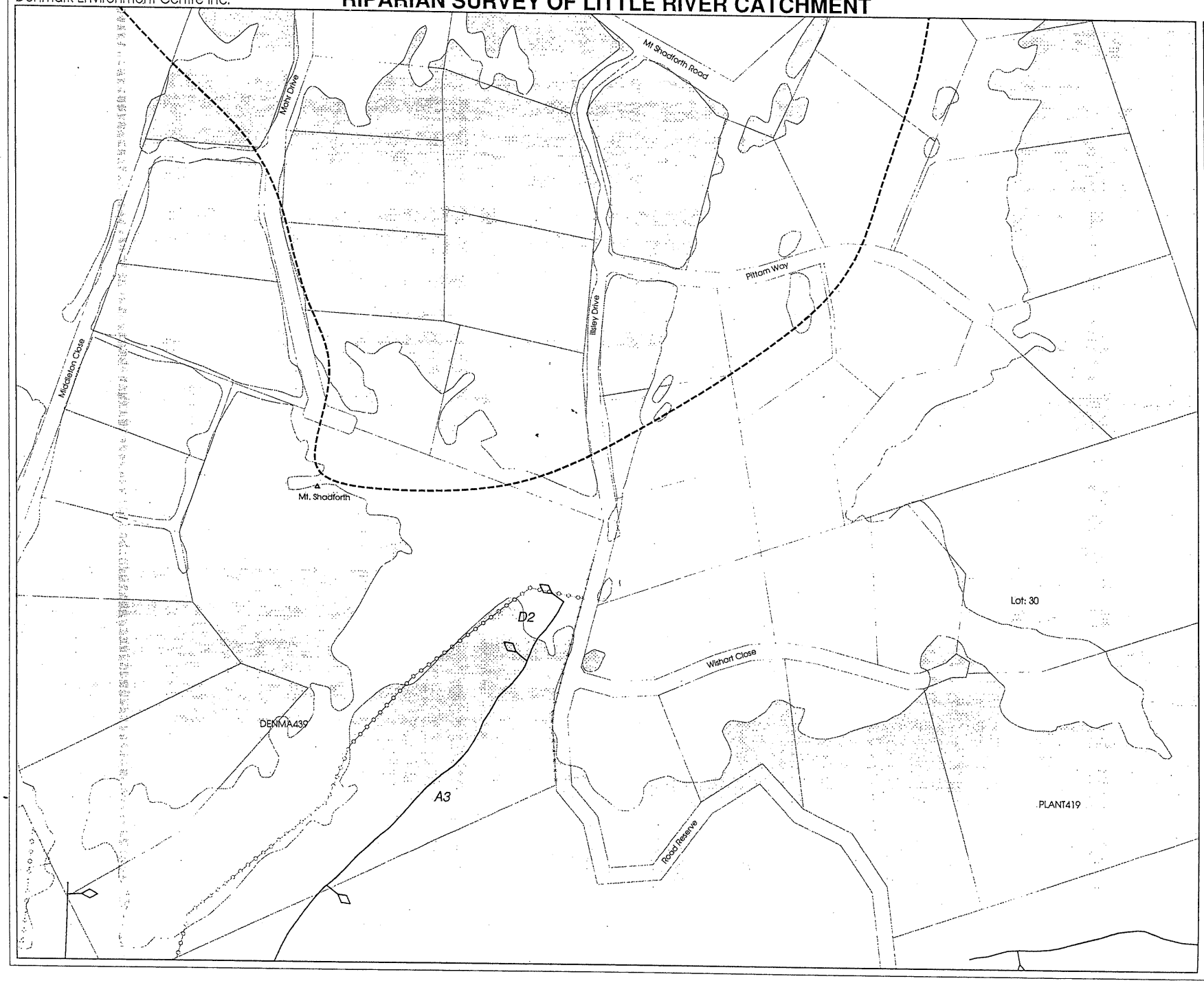
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	300 Metres
Length of watercourse Fencing Recommended	N/A	725 Metres
Number of severe erosion sites	N/A	Nil
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: N/A
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): Nil
Advice on Revegetation Species and Preparation	N/A	N/A
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	Nil
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: N/A
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 9



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
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LITTLE RIVER SURVEY- Map 10 See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: Loc. 406, 407, 410, part 420, Res. 18340.
Survey Project Officer: Alex Syme
Date: August 1996

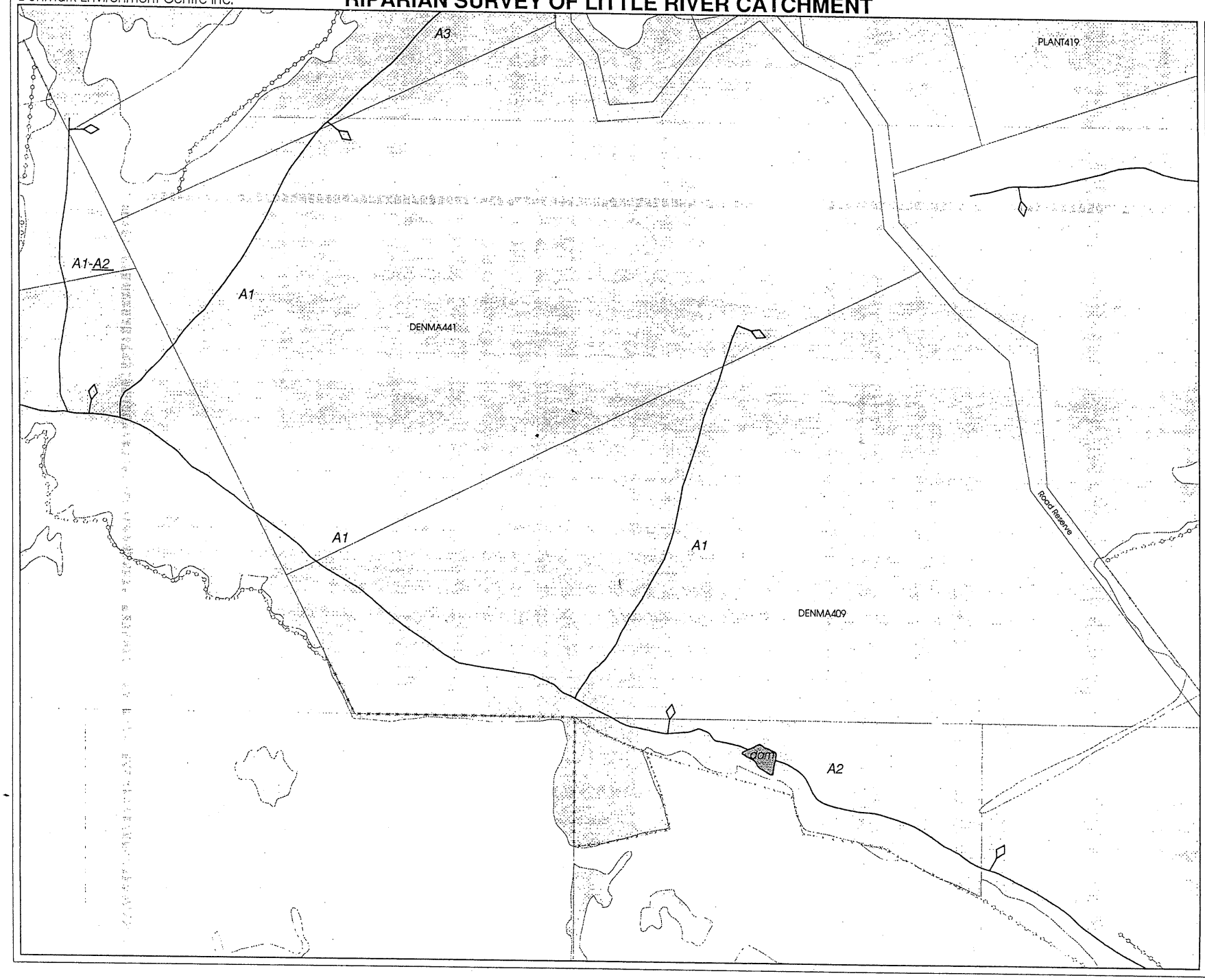
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	1,500 Metres
Length of watercourse Fencing Recommended	N/A	525 Metres
Number of severe erosion sites	N/A	Nil
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: N/A
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): Nil
Advice on Revegetation Species and Preparation	N/A	N/A
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	Nil
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: N/A
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 10



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

Loc. Numbers of Adjacent Properties: 405, 406, 407, 665, 666.
Survey Project Officer: Alex Syme
Date: August 1996

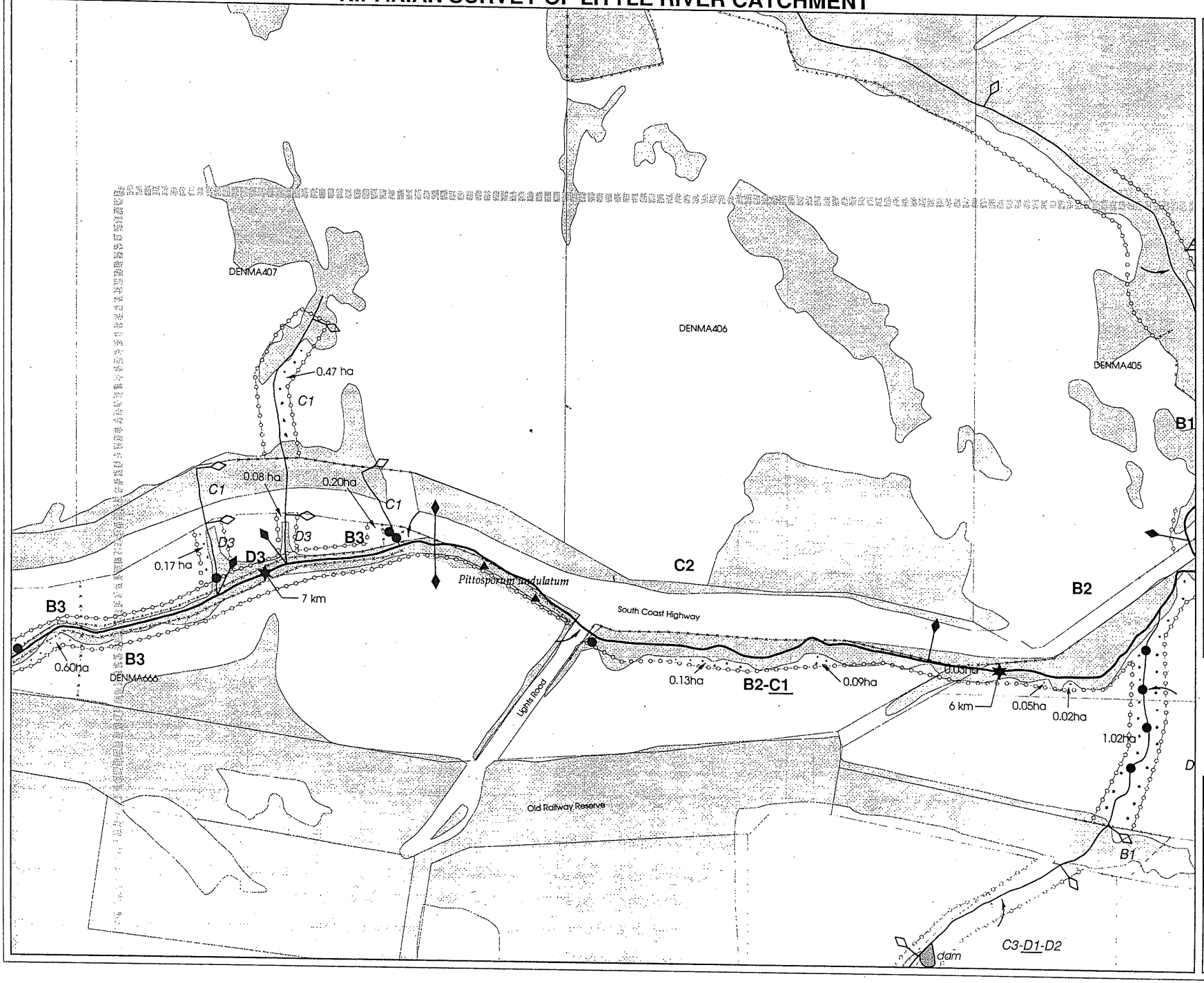
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	1,900 Metres	750 Metres
Length of watercourse Fencing Recommended	1,500 Metres Comment: Includes relocating some existing fence further out from channel.	1,825 Metres Comment: Includes relocating some existing fence further out from channel.
Number of severe erosion sites	2	6 to 10
Advice on remedial measures required for these sites	Recommendation: Exclude stock from frequent use of crossing points. Brush, hand plant.	Recommendation: Exclude stock from frequent use of crossing points. Elsewhere, fence and regenerate.
Approximate area along watercourse requiring revegetation work	Area (Ha.): 1.3	Area (Ha.): 2.7
Advice on Revegetation Species and Preparation	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens Eucalyptus marginata* (Select further species from Appendix 1)	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens Eucalyptus marginata* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	2	Nil
Advice on Rehabilitation of these sites	Recommendation: Treat weeds, allow natural regeneration.	Recommendation: N/A
Other Management Related Information for this map	Recent Main Roads WA construction work is currently a major source of sediment export. Stabilising of disturbed soil urgently required.	Recent Main Roads WA construction work is currently a major source of sediment export. Stabilising of disturbed soil urgently required.

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 11



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- Serious weed infestation and species — *Watsonia*
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 12 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: 2481, 4330, 4329, part 4328.
Survey Project Officer: Alex Syme
Date: August 1996

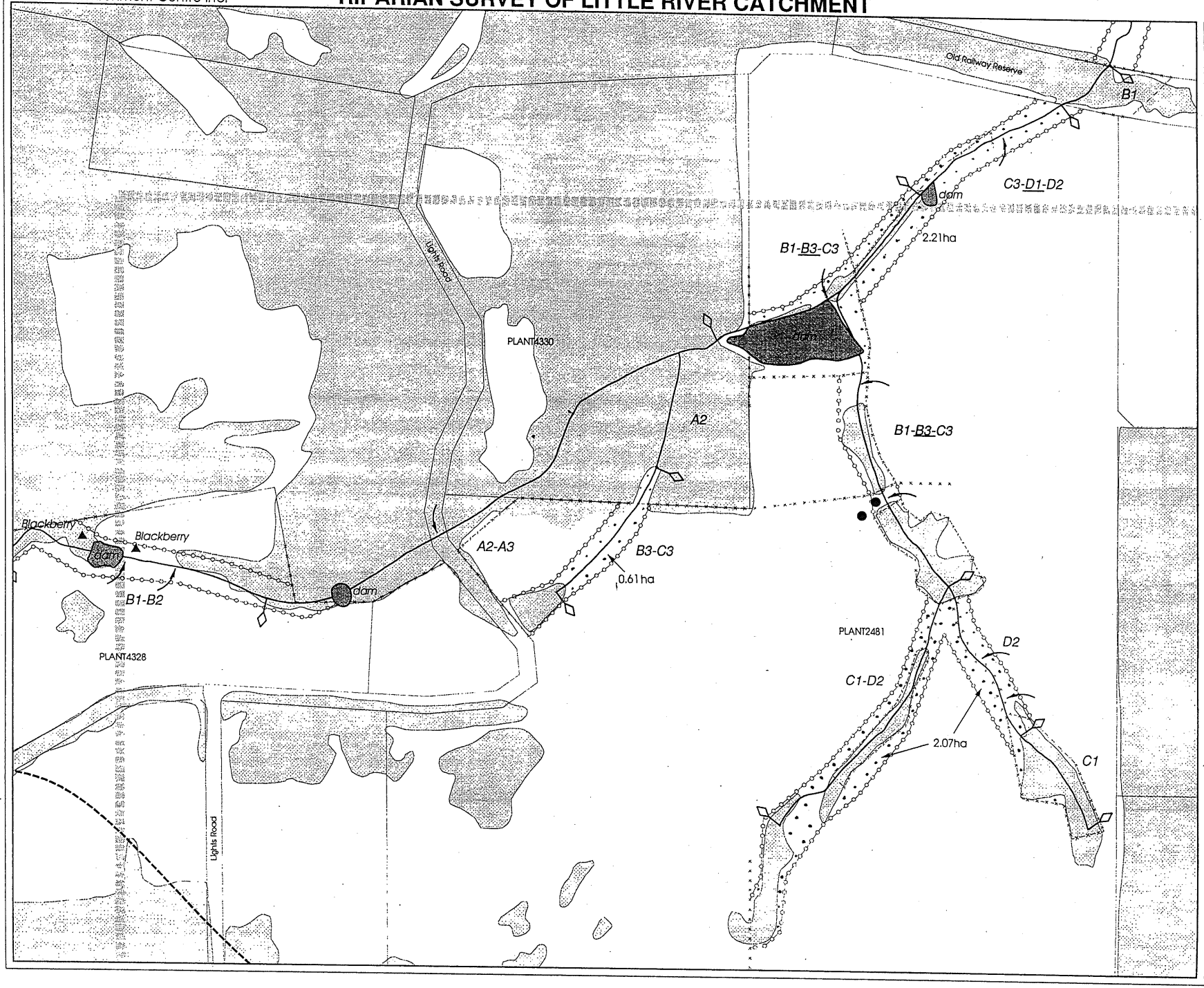
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	3,575 Metres
Length of watercourse Fencing Recommended	N/A	2,450 Metres Comment: Includes relocating some existing fence further out from channel.
Number of severe erosion sites	N/A	3
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: Exclude stock from frequent use of crossing points. Elsewhere, fence and regenerate.
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): 3.9
Advice on Revegetation Species and Preparation	N/A	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens Eucalyptus marginata* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	1
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: Treat blackberry, allow natural regeneration.
Other Management Related Information for this map	N/A	Fence very close to channel in some areas.

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 12



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

- **A1-A2** River foreshore condition mainly A2 with some A1
- *A1-A2* Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

n

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
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LITTLE RIVER SURVEY- Map 13. See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: Loc. 413, 415, 423, part 414.
Survey Project Officer: Alex Syme
Date: August 1996

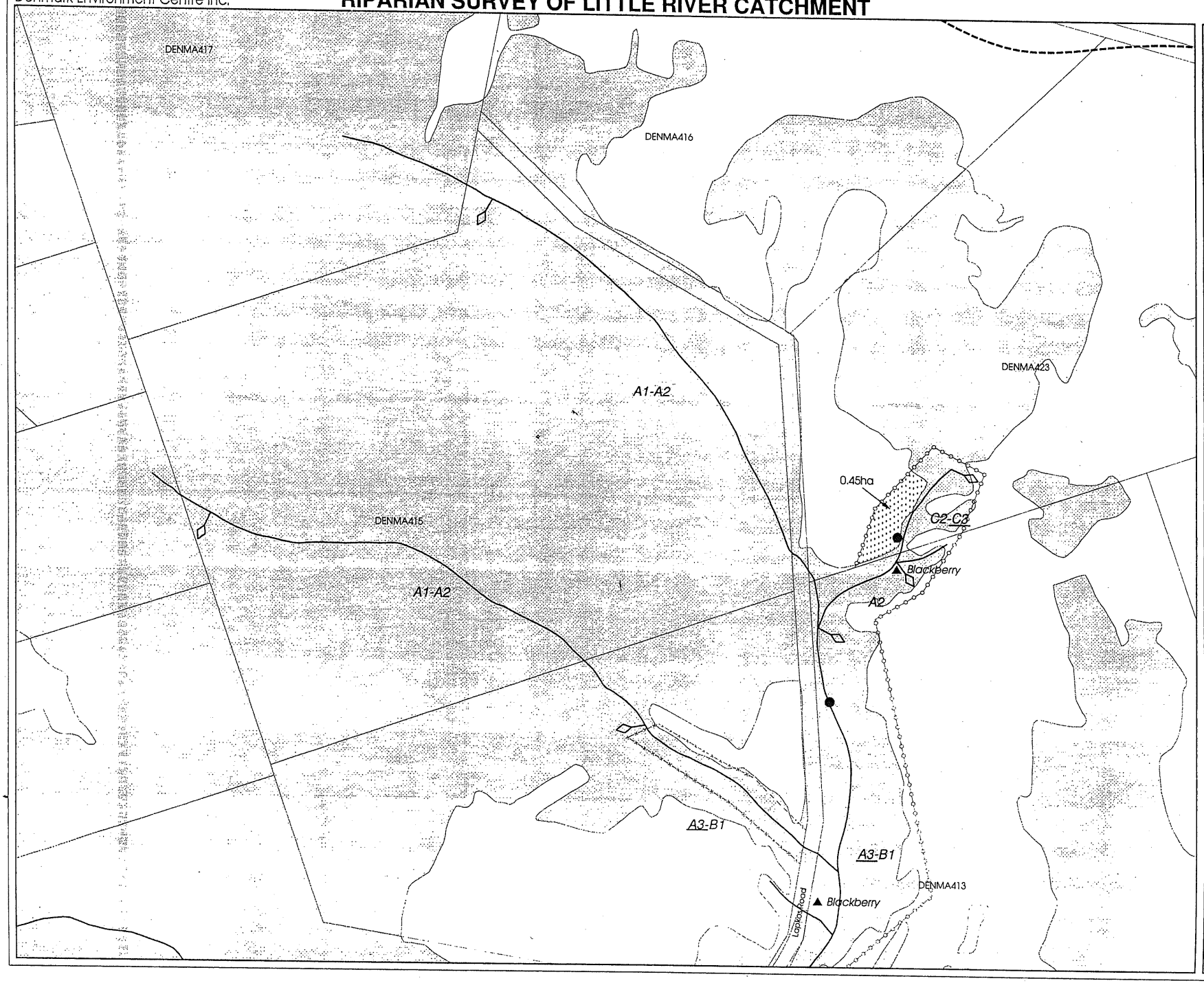
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	525 Metres
Length of watercourse Fencing Recommended	N/A	650 Metres
Number of severe erosion sites	N/A	Nil
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: N/A
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): Nil
Advice on Revegetation Species and Preparation	N/A	N/A
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	2
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: Treat blackberry
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 13



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- P — Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 14 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: Lot 3. Loc. 412, 411, 413, Lot 1 of 414.
Survey Project Officer: Alex Syme
Date: August 1996

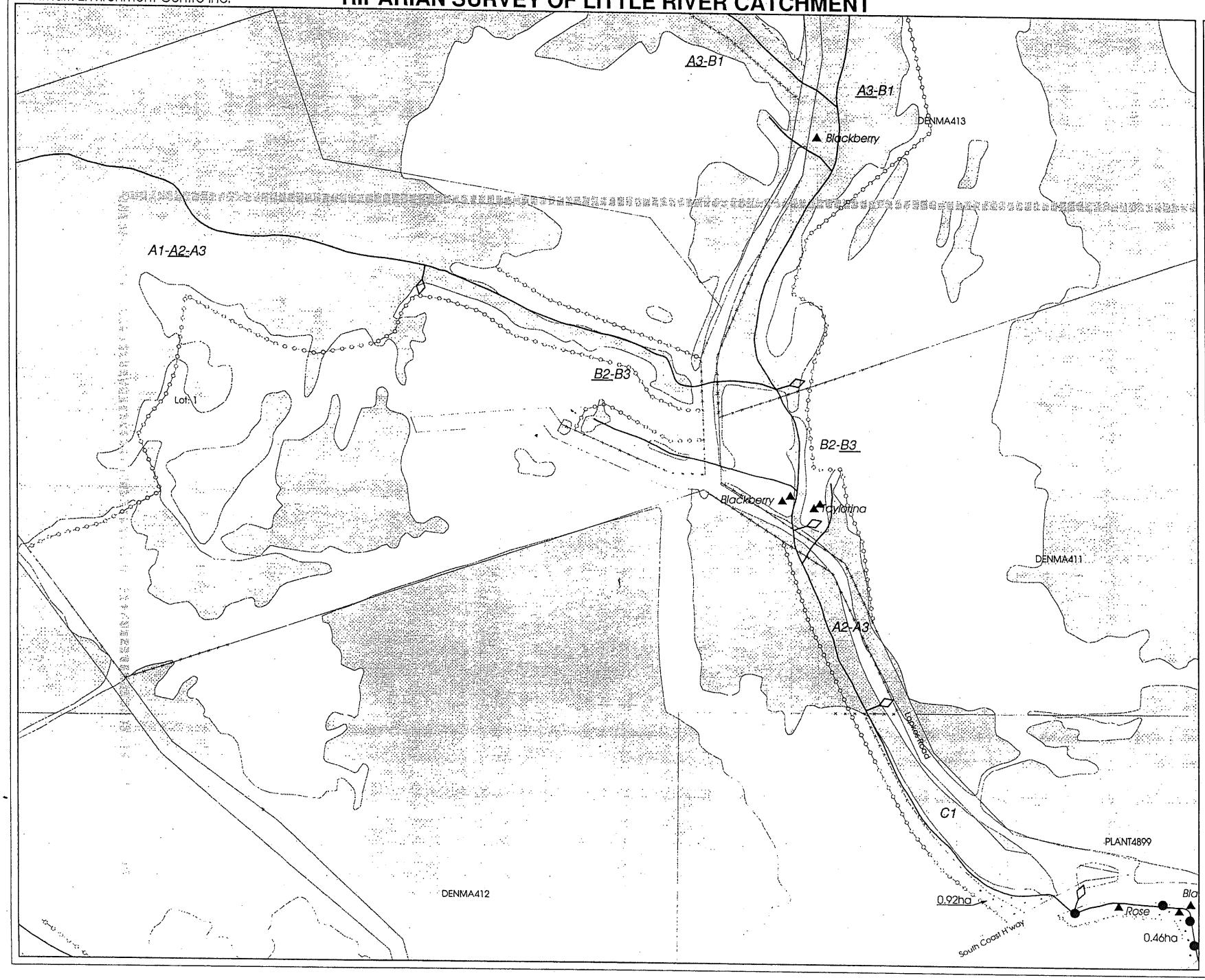
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	1,975 Metres
Length of watercourse Fencing Recommended	N/A	2825 Metres Comment: Includes relocating some existing fence.
Number of severe erosion sites	N/A	4
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: Exclude stock. Brush, hand plant.
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): 1.4
Advice on Revegetation Species and Preparation	N/A	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens Eucalyptus marginata* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	5
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: Treat weeds, allow natural regeneration.
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 14



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- ▲ *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
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LITTLE RIVER SURVEY- Map 15 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: Lots 10, 11 & 3. Loc. 465, 405, 412.
Survey Project Officer: Alex Syme
Date: August 1996

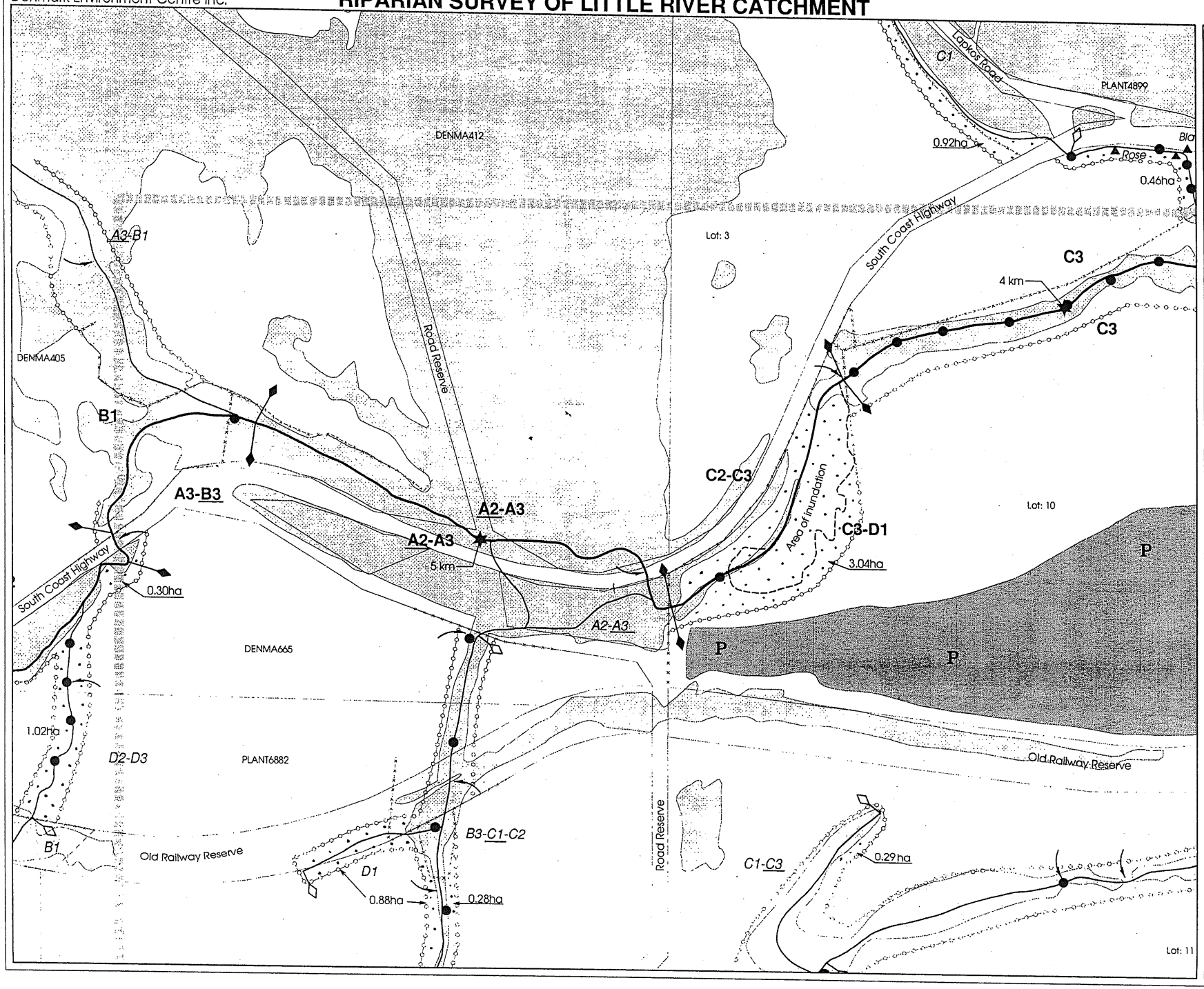
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	1,725 Metres	750 Metres
Length of watercourse Fencing Recommended	850 Metres Comment: Nil	2,450 Metres
Number of severe erosion sites	Numerous/continuous on Lot 10. 2 others	7
Advice on remedial measures required for these sites	Recommendation: For the Lot 10 section of river may require a soft engineering techniques (construction of pools and riffles) as recommend in the report on Little River Angus MacKenzie (1996) For others exclude stock.	Recommendation: Exclude stock from frequent use of crossing points. Brush, hand plant.
Approximate area along watercourse requiring revegetation work	Area (Ha.): 3.	Area (Ha.): 1.3
Advice on Revegetation Species and Preparation	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla* and species suitable for a wetland area.(Select further species from Appendix 1)	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	Nil	Nil
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: N/A
Other Management Related Information for this map	The severe and continuing erosion on Lot 10 requires urgent attention. Costings to achieve this are contained in MacKenzie,1996)	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 15



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- P — Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- Serious weed infestation and species — *Watsonia*
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
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Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
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Loc. Numbers of Adjacent Properties:
Survey Project Officer: Alex Syme
Date: August 1996

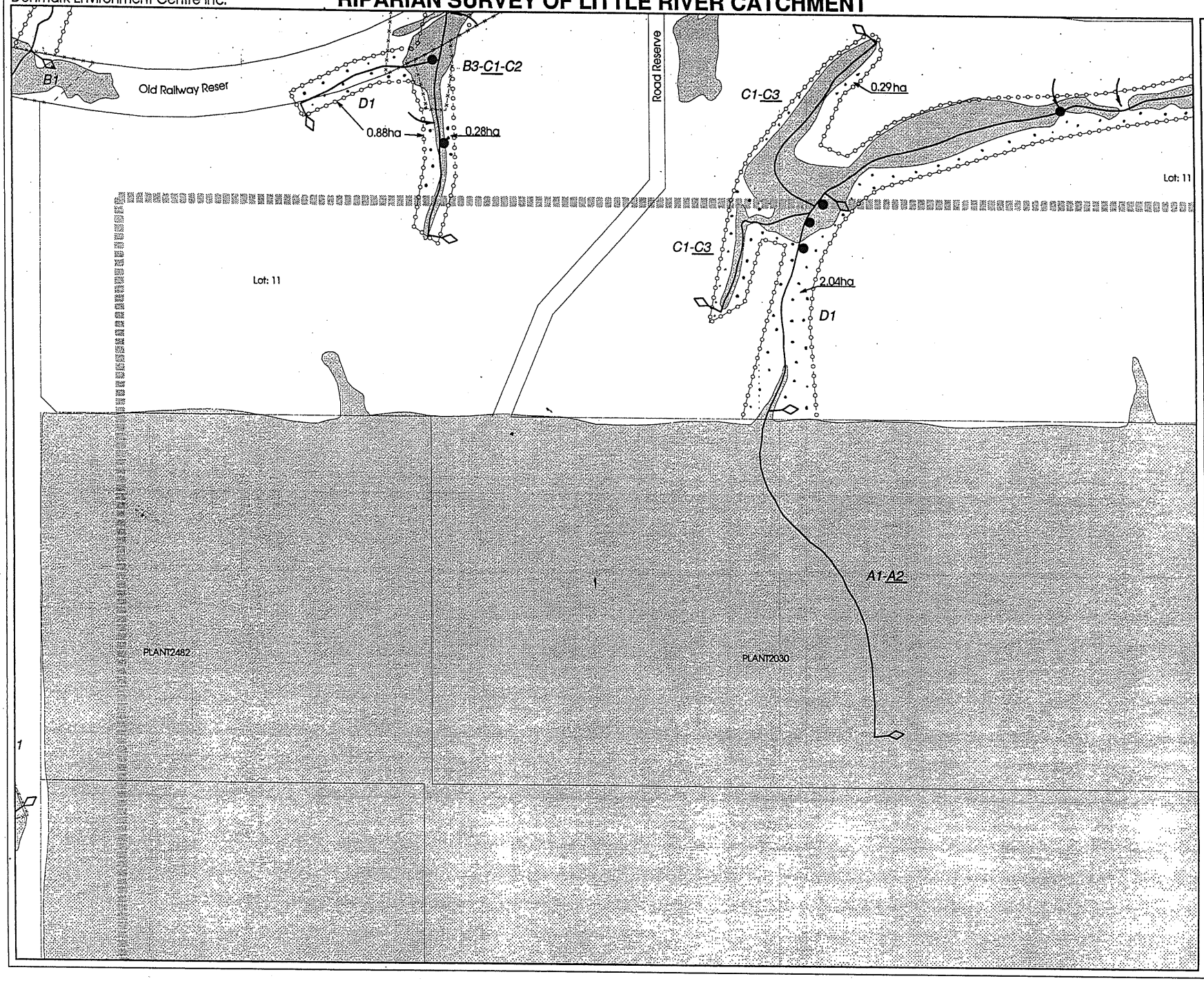
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	Nil
Length of watercourse Fencing Recommended	N/A	675 Metres
Number of severe erosion sites	N/A	2
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: Exclude stock from frequent use of crossing points. Brush, hand plant.
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): 2.1
Advice on Revegetation Species and Preparation	N/A	Hand plant *Agonis juniperina , Eucalyptus calophylla , Eucalyptus patens Eucalyptus marginata* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	Nil
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: N/A
Other Management Related Information for this map	N/A	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 16



LEGEND

Survey Class — Foreshore Condition

- A — A1 Pristine; A2 Near Pristine; A3 Slightly disturbed
- B — B1 Degraded-weed infested; B2 Degraded-heavily weed infested; B3 Degraded-weed dominated
- C — C1 Erosion prone; C2 Soil exposed; C3 Eroded
- D — D1 Ditch-eroding; D2 Ditch-freely eroding; D3 Drain-weed dominated

Example foreshore condition:-

- **A1-A2** River foreshore condition mainly A2 with some A1
- *A1-A2* Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
RMB 1015 Lapkos Rd Denmark WA Ph (098) 482428

LITTLE RIVER SURVEY- Map 17 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: 402, 708, 403.
Survey Project Officer: Alex Syme
Date: August 1996

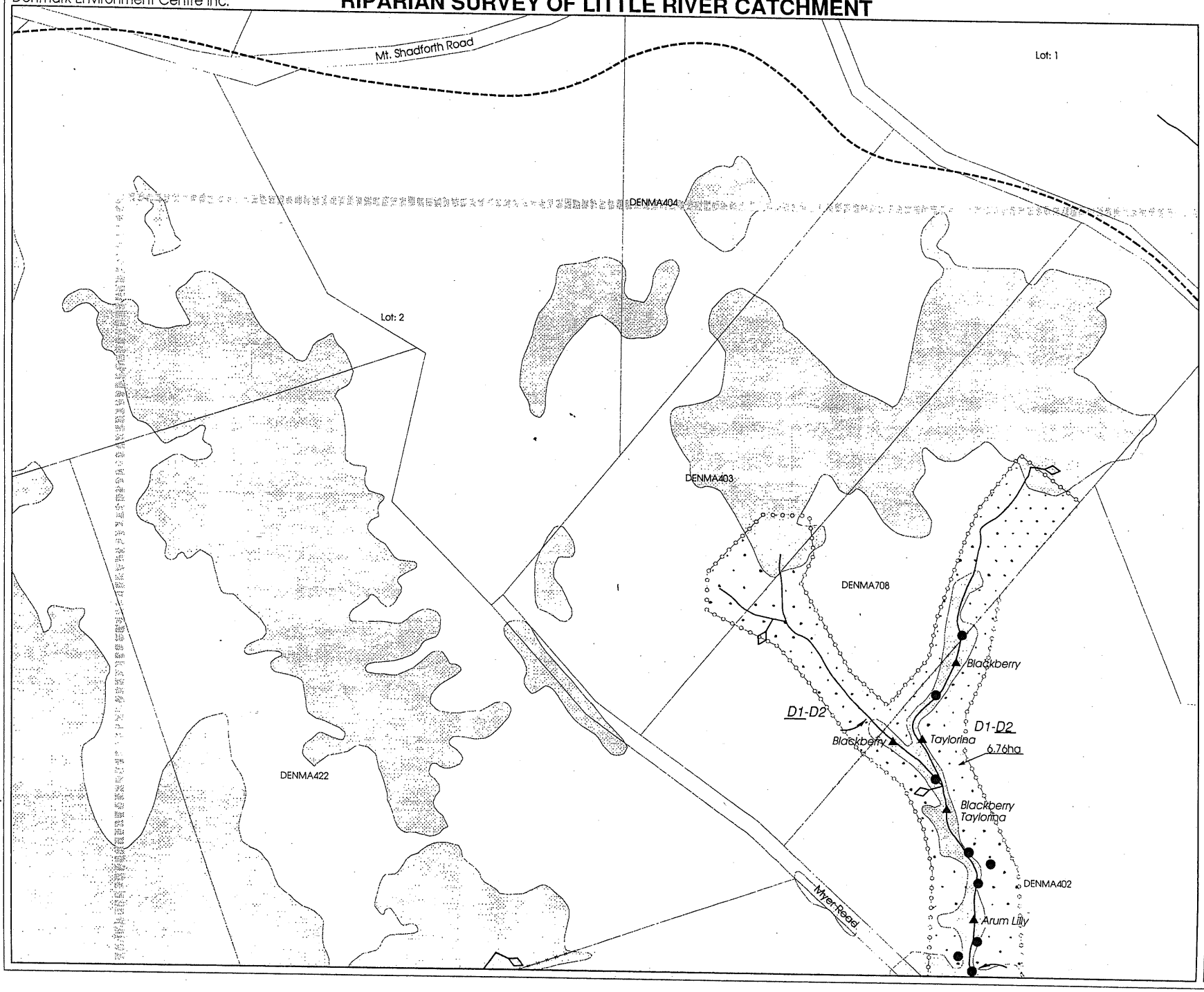
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	575 Metres
Length of watercourse Fencing Recommended	N/A	1975 Metres
Number of severe erosion sites	N/A	9
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: Exclude stock as soon as possible. Seek further on ground advice on how to rehabilitate.
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): 6.8
Advice on Revegetation Species and Preparation	N/A	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	Numerous
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: Treat weeds in conjunction with watercourse rehabilitation work.
Other Management Related Information for this map	N/A	Remaining vegetation and the watercourses on Loc. 402, 708, 403 are severely threatened. Measures to protect and regenerate are urgent.

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 17



LEGEND

Survey Class		Foreshore Condition
A	A1	Pristine
	A2	Near Pristine
	A3	Slightly disturbed
B	B1	Degraded-weed infested
	B2	Degraded-heavily weed infested
	B3	Degraded-weed dominated
C	C1	Erosion prone
	C2	Soil exposed
	C3	Eroded
D	D1	Ditch-eroding
	D2	Ditch-freely eroding
	D3	Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
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LITTLE RIVER SURVEY- Map 18 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: 615, 421, Lot 1.
Survey Project Officer: Alex Syme
Date: August 1996

MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	625 Metres	2,325 Metres
Length of watercourse Fencing Recommended	225 Metres Comment: Nil	3825 Metres Comment: Includes relocating some existing fence.
Number of severe erosion sites	1	18
Advice on remedial measures required for these sites	Recommendation: Dam overflow channel needs a soft engineering solution to reduce erosion and allow for native fish migration upstream. For more details see report prepared by Angus MacKenzie (MacKenzie, 1996) for the Denmark Environment Centre	Recommendation: Exclude stock from frequent use of crossing points. Brush, hand plant. Treat dam spill way and 3 eroding sections of channelised stream deepened with machinery, with soft engineering options (MacKenzie, 1996:6)
Approximate area along watercourse requiring revegetation work	Area (Ha.): 0.3	Area (Ha.): 4.5
Advice on Revegetation Species and Preparation	Hand plant Adjacent vegetation is *Agonis juniperina , E. diversicolor Eucalyptus calophylla.* (Select further species from Appendix 1)	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens Eucalyptus megacarpa.* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	Nil	3 Urgently treat Watercress infestation in creek line below Myers Road. Ensure dead stock are removed from watercourses.
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: Treat weeds, allow natural regeneration.
Other Management Related Information for this map	The Large Dam could have habitat features implemented for bird habitat (islands, establishment of fringing vegetation etc).	Remaining vegetation on Loc. 615 is severely threatened. Measures to protect and regenerate are urgent.

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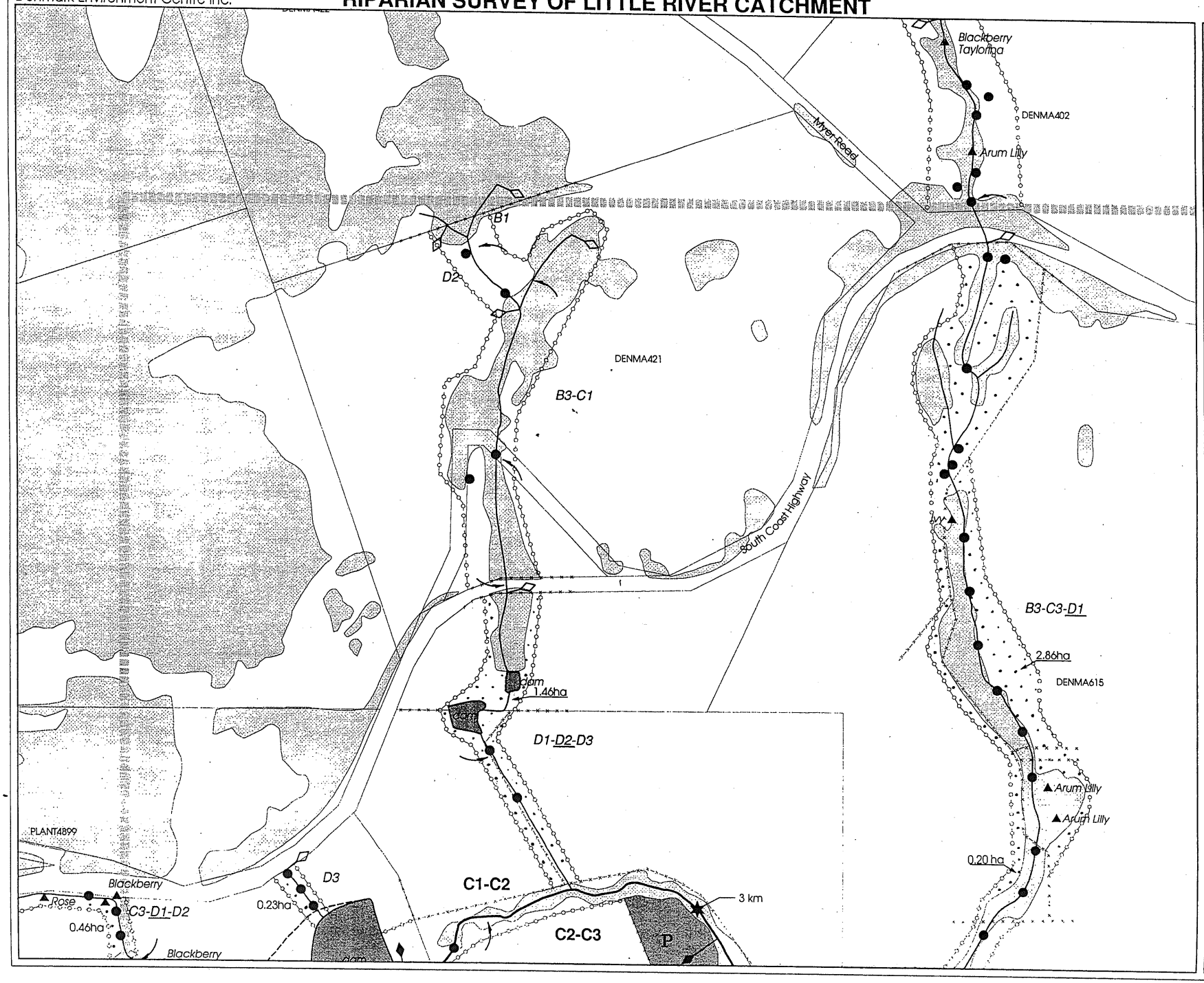
RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 18



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
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Loc. Numbers of Adjacent Properties: 1977, 615, lots 1, 10 & 11.
Survey Project Officer: Alex Syme
Date: August 1996

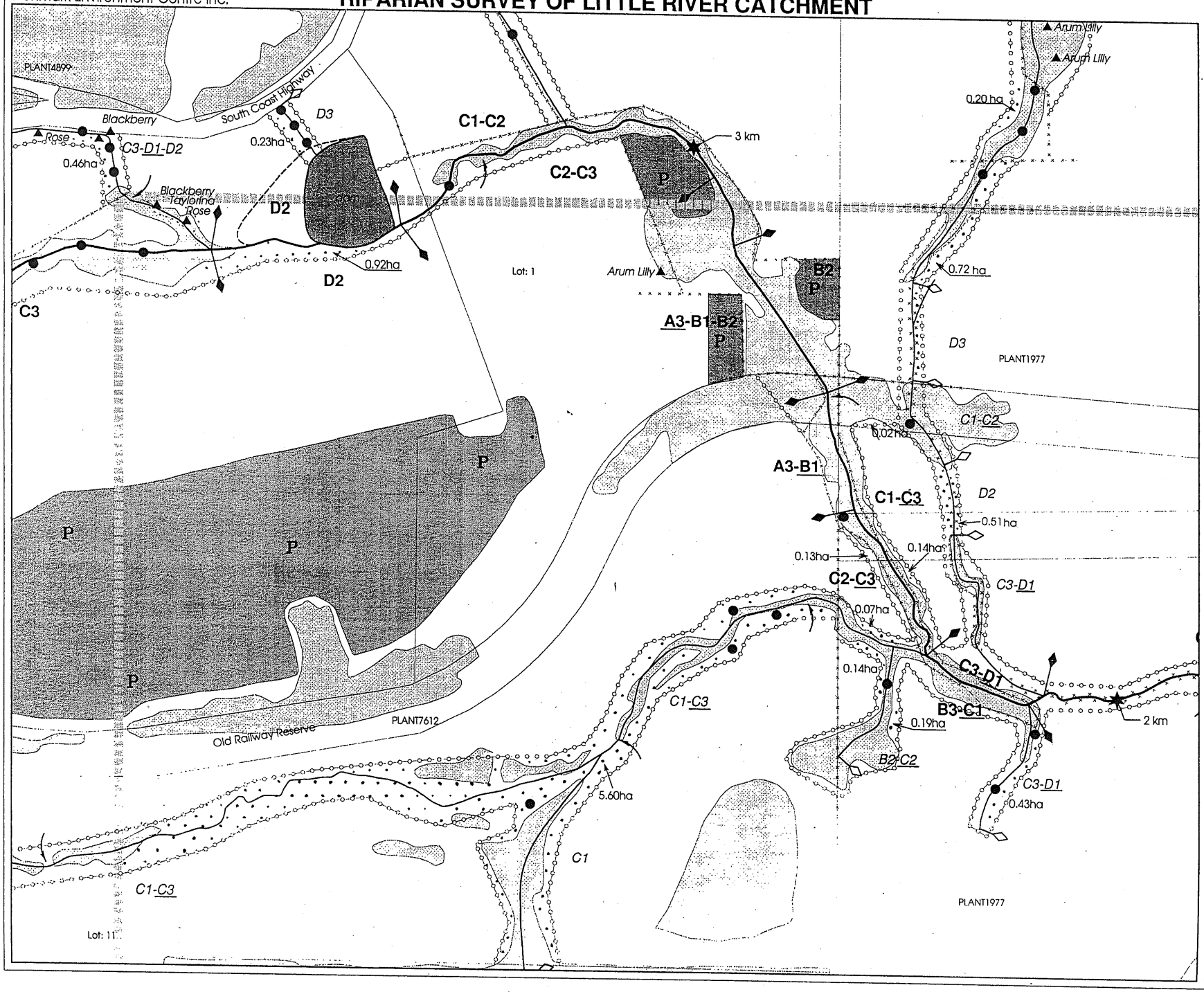
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	2,525 Metres	1,650 Metres
Length of watercourse Fencing Recommended	1,875 Metres Comment: Includes relocating existing fence further out from channel.	4,650 Metres Comment: Includes relocating existing fence further out from channel.
Number of severe erosion sites	2	2
Advice on remedial measures required for these sites	Recommendation: Rehabilitation Treatment elsewhere in catchment should relieve erosive pressures on these sites.	Recommendation: Exclude stock, brush, hand plant.
Approximate area along watercourse requiring revegetation work	Area (Ha.): 1.2	Area (Ha.): 7.6
Advice on Revegetation Species and Preparation	Hand plant Adjacent vegetation is *Agonis juniperina , E. diversicolor Eucalyptus calophylla, Eucalyptus patens* (Select further species from Appendix 1)	Hand plant *Agonis juniperina , E. diversicolor , Eucalyptus calophylla , Eucalyptus patens* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	2	Nil
Advice on Rehabilitation of these sites	Recommendation: Treat weeds, allow natural regeneration.	Recommendation: N/A
Other Management Related Information for this map		

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 19



LEGEND

Survey Class		Foreshore Condition
A	A1	Pristine
	A2	Near Pristine
	A3	Slightly disturbed
B	B1	Degraded-weed infested
	B2	Degraded-heavily weed infested
	B3	Degraded-weed dominated
C	C1	Erosion prone
	C2	Soil exposed
	C3	Eroded
D	D1	Ditch-eroding
	D2	Ditch-freely eroding
	D3	Drain-weed dominated

Example foreshore condition:-

- **A1-A2** River foreshore condition mainly A2 with some A1
- *A1-A2* Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- P — Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

n

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
Funded with assistance from the Gordon Ried Foundation for Conservation and the Wilson Inlet Management Authority
Project co-ordinator APACE Green Skills.
Produced by Watershed Digital Mapping
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Loc. Numbers of Adjacent Properties: 2099, 616.
Survey Project Officer: Alex Syme/Diane Harwood
Date: August 1996

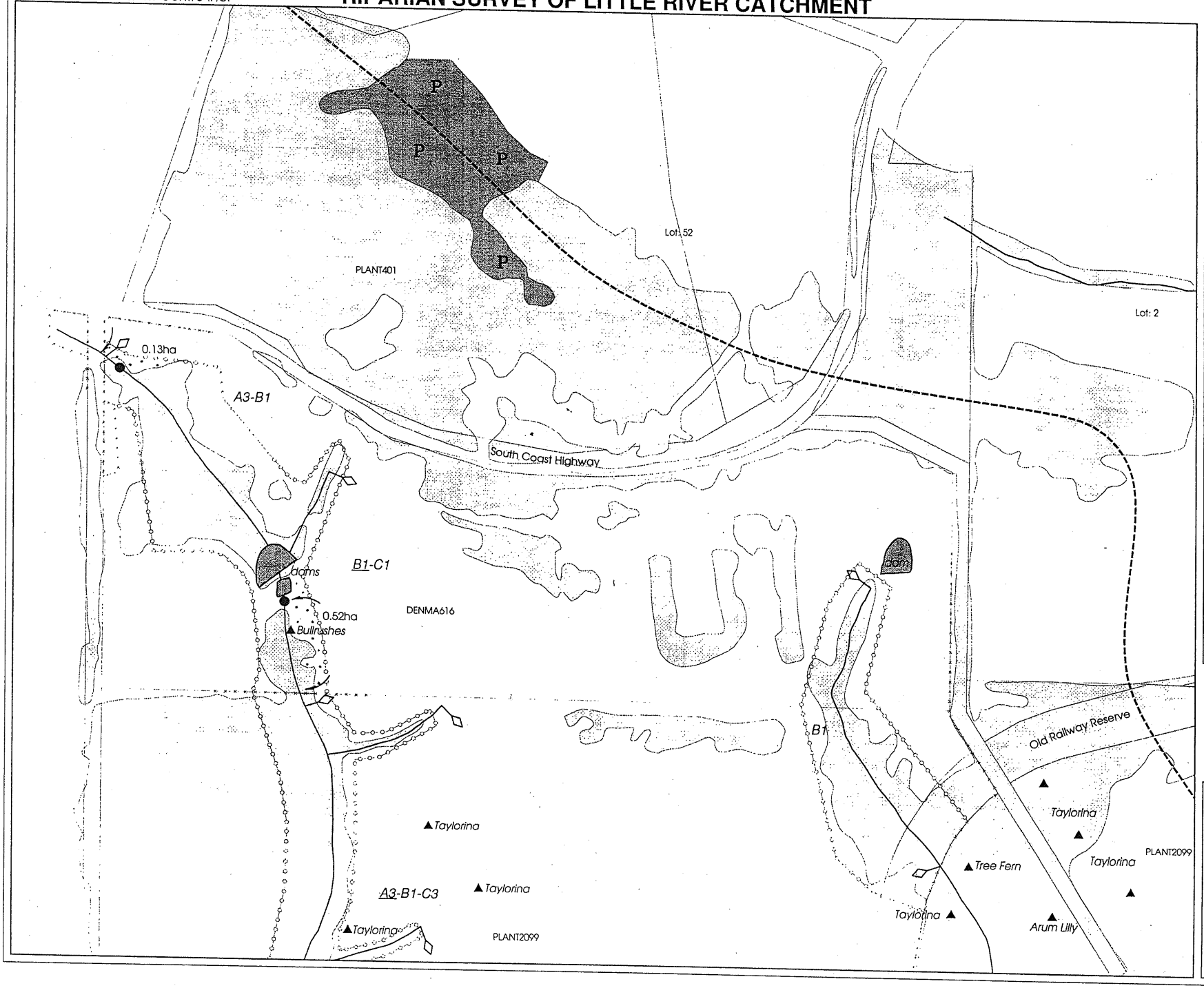
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	N/A	1,550 Metres
Length of watercourse Fencing Recommended	N/A	3025 Metres
Number of severe erosion sites	N/A	1
Advice on remedial measures required for these sites	Recommendation: N/A	Recommendation: Exclude stock from frequent use of this crossing point.
Approximate area along watercourse requiring revegetation work	Area (Ha.): N/A	Area (Ha.): 0.65
Advice on Revegetation Species and Preparation	N/A	Hand plant Adjacent vegetation is *Eucalyptus calophylla , Eucalyptus marginata, Eucalyptus patens.* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	N/A	8
Advice on Rehabilitation of these sites	Recommendation: N/A	Recommendation: Treat weeds, allow natural regeneration.
Other Management Related Information for this map	N/A	To allow successful regeneration and to shadow out weeds in areas after fencing, exclude fire for as long as possible.

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 20



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
Prepared for the Denmark Environment Centre Inc. as part of the riparian survey of the Little River catchment.
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Project co-ordinator APACE Green Skills.
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LITTLE RIVER SURVEY- Map 21 — See Map 1.2 for general location

Loc. Numbers of Adjacent Properties: Lot 31, 2099, 2098,1977.
Survey Project Officer: Alex Syme/Diane Harwood
Date: August 1996

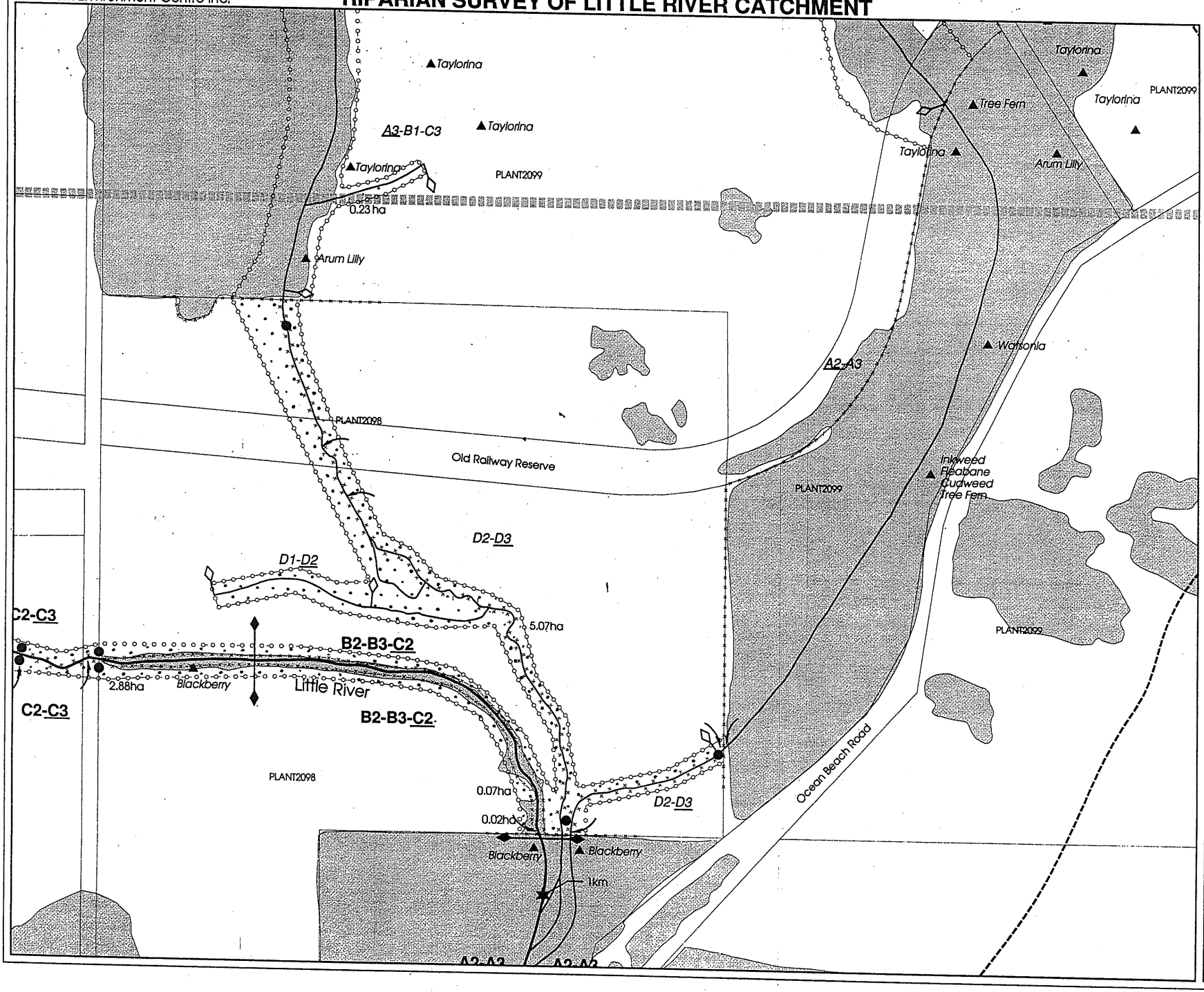
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	1,925 metres	3,125 metres
Length of watercourse Fencing Recommended	1,600 metres Comment: Includes relocating existing fence further out from channel.	3,050 metres Comment: Includes relocating existing fence on 'D' condition sections further out from channel.
Number of severe erosion sites	3	3
Advice on remedial measures required for these sites	Recommendation: Exclude stock from frequent use of these crossing points.	Recommendation: Exclude stock from frequent use of these crossing points.
Approximate area along watercourse requiring revegetation work	Area (Ha.): 2.5	Area (Ha.): 5.3
Advice on Revegetation Species and Preparation	Hand plant Adjacent vegetation is *Eucalyptus calophylla , Eucalyptus marginata, Eucalyptus patens.* (Select further species from Appendix 1)	Mound - perhaps herring bone patten to watercourses, Hand plant. Adjacent vegetation is *Eucalyptus calophylla , Eucalyptus marginata, Eucalyptus patens.* (Select further species from Appendix 1)
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	2	6
Advice on Rehabilitation of these sites	Recommendation: Treat weeds, allow natural regeneration.	Recommendation: Treat weeds, allow natural regeneration.
Other Management Related Information for this map	Degraded condition of foreshore reflects past landuse practices. Rehabilitation requires some sacrifice of land currently used.	Degraded condition of foreshore reflects past landuse practices. Rehabilitation requires some sacrifice of land currently used.

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 21



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km — Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- Watsonia — Serious weed infestation and species
- 1.30 ha — Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
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Project co-ordinator APACE Green Skills.
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Loc. Numbers of Adjacent Properties: Foreshore reserve, suburban lots, lot 31.
Survey Project Officer: Alex Syme/Diane Harwood
Date: August 1996

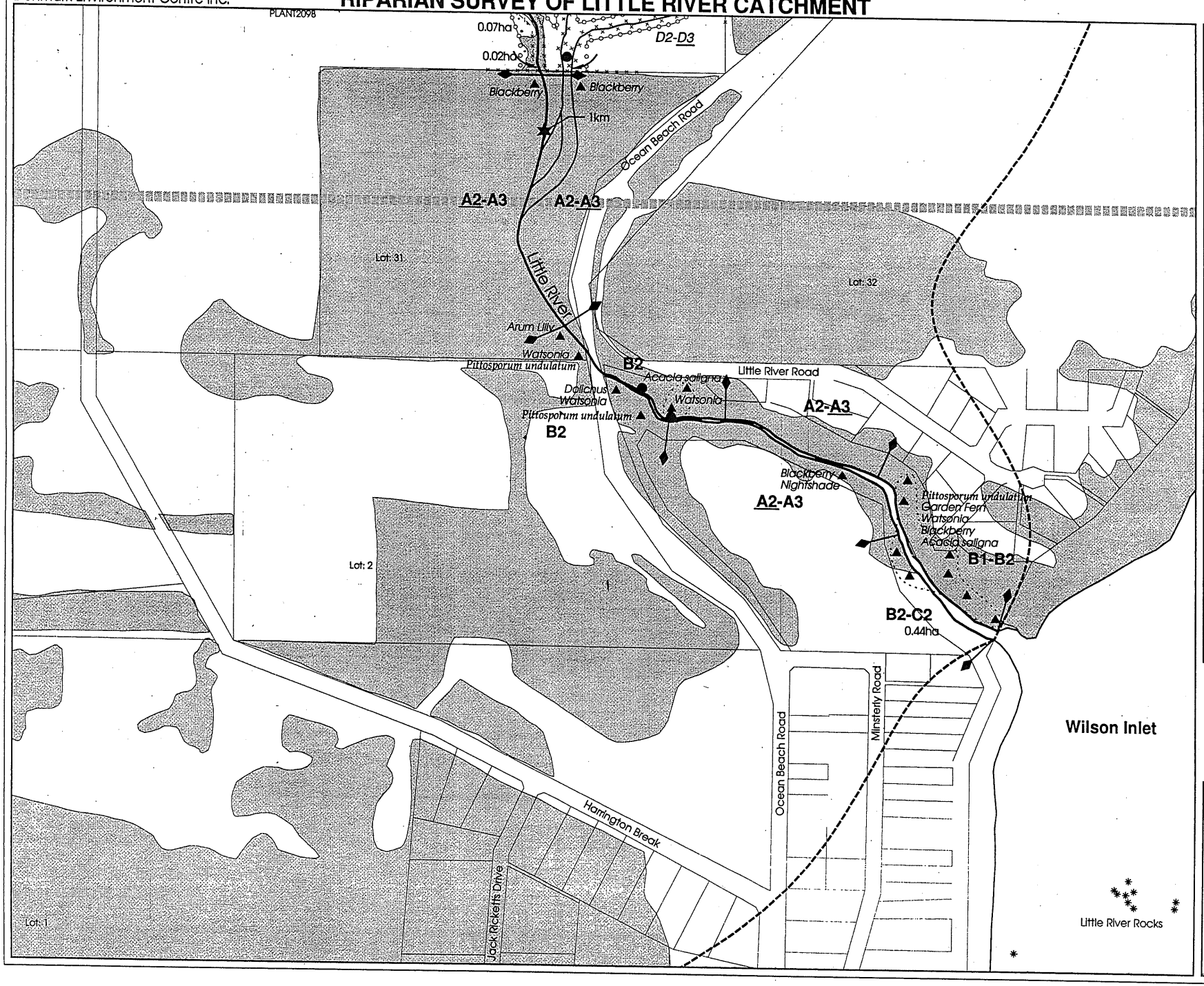
MANAGEMENT AND REHABILITATION ADVICE TO LANDHOLDERS

	Little River	Tributaries/Tributary
Length of watercourse Fencing In Place	Nil Comment:	N/A
Length of watercourse Fencing Recommended	Nil	N/A
Number of severe erosion sites	2	N/A
Advice on remedial measures required for these sites	Recommendation: (a) Brush & allow natural revegetation. (b) Disperse discharge from road drainage pipe.	Recommendation: N/A
Approximate area along watercourse requiring revegetation	Area (Ha.): 0.44	Area (Ha.): N/A
Advice on Revegetation Species and Preparation	Hand plant Adjacent vegetation is *Agonis juniperina , E. diversicolor Eucalyptus calophylla and Eucalyptus cornuta* (Select further species from Appendix 1)	
Number of other sites requiring rehabilitation work (ie Serious weed infestations)	Numerous	N/A
Advice on Rehabilitation of these sites	Recommendation: Remove weeds as described in Chapter 9.5 Vegetation rehabilitation. Hand plant species indigenous to area.	Recommendation: N/A
Other Management Related Information for this map	Clearing of the public land foreshore, on the left bank, has occurred from the river mouth upstream for some distance. This public land should not be considered by adjacent landholders as areas onto which to extend their gardens and lawns. See above section.	

Denmark Environment Centre Inc.

RIPARIAN SURVEY OF LITTLE RIVER CATCHMENT

MAP No. 22



LEGEND

Survey Class	Foreshore Condition
A	A1 Pristine A2 Near Pristine A3 Slightly disturbed
B	B1 Degraded-weed infested B2 Degraded-heavily weed infested B3 Degraded-weed dominated
C	C1 Erosion prone C2 Soil exposed C3 Eroded
D	D1 Ditch-eroding D2 Ditch-freely eroding D3 Drain-weed dominated

Example foreshore condition:-

A1-A2 River foreshore condition mainly A2 with some A1

A1-A2 Tributary foreshore condition mainly A2 with some A1

- Road
- Location boundary
- Catchment boundary
- River
- Tributary
- Remnant vegetation
- Pn Existing tree planting
- River class boundary
- Tributary class boundary
- Relevant existing fence at time of survey
- Recommended fencing
- 2km Distance marker (distance from river mouth)
- Point of severe erosion or subsidence
- Watercourse crossing point
- *Watsonia* Serious weed infestation and species
- 1.30 ha Recommended area needing rehabilitation/ revegetation plus approximate area
- Extent of map overlap

N

0 50 100 150 200m

Scale 1:5,000

Projection:
Universal Transverse Mercator
Grid: A.M.G., zone 50
Date: October 22, 1996
Source Data:
Based on field survey and interpretation of 1:20,000 aerial photographs Job 930700, Jan '93 Runs 4 and 5.
Cadastral and topographic digital information supplied by the Dept. of Land Administration West. Aust.
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