



water reforms

Stressed Rivers Assessment Report

Far Western NSW Streams

Stressed Rivers Assessment Report
Far Western NSW Streams



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Stressed rivers assessment
report Hunter region : Far
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All Members,
Lowbidgee Inter-departmental
Steering Committee

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Dear Sir/Madam,

26 MAY 1989

Re: Lowbidgee Project Status Report

The enclosed status report has been prepared to provide you with an update on the current situation regarding the development of a management plan for the Lowbidgee.

As explained in the Status Report, Stage One of the Management Plan is due for release in July 1989; it is currently in press. Stage Two will be released at a later date and will address those aspects not dealt with in Stage One.

The efforts and advice of the Steering Committee have been invaluable to date and I would like to express my appreciation on behalf of the Department. Because I wish to continue this liaison, there will be further opportunity for members to review and comment on the plan so that these views can be taken into consideration in Stage Two. I propose to convene a meeting after the release of the Stage One report to facilitate this exchange.

I look forward to your continuing co-operative involvement in this matter. Please feel free to contact myself in Leeton ((069) 533677), or Paul Wettin (895-7469) or Fiona Keenan (895-7472) at our Head Office regarding any of the above matters.

Yours faithfully,

Paul Wettin

Paul Wettin
Senior Environmental Officer

for Lindsay Beck,
Project Manager

Encl.

To : INTERDEPARTMENTAL STEERING COMMITTEE ON THE
LOWBIDGEE WETLANDS

From: Lindsay Beck - Project Manager

DEPARTMENT OF WATER RESOURCES
STATUS REPORT - LOWBIDGEE PROJECT
MAY 1989

The Department of Water Resources wishes to continue the involvement of the Steering Committee in the management of the Lowbidgee Flood Control and Irrigation District and the protection of its agriculture, wetlands and other values. The following update outlines the action taken on recommendations of the last Committee meeting on 21st July 1988, and the progression of the management plan.

1 "Protected land"

Land protected from clearing within the lignum wetlands includes 23,800 ha of "Protected Lands" under the Soil Conservation Act, and further small discrete areas protected by the voluntary agreement of landholders.

1.1 Area of Protected Lands

Initial areas (24,400 ha) were declared in May 1988, and were intended to be interim, prior to consultation with scientists and landholders to establish agricultural and environmental needs. Following these consultations, the final areas of Protected Land (Figure 1) were declared on 11th August 1988 .

The Protected Lands are under two categories :

- (i) Habitat Protection (22,800 ha), administered by the DWR. This area is equal to 93 percent of the lignum areas protected in May 1988 by the interim controls. This includes large tracts of lignum within the planned floodway system, and "special habitats" some of which are outside the floodways.
- (ii) Prescribed Streams and Lakes (1,000 ha). The DWR administers applications for most purposes within these areas, however the Soil Conservation Service deals with applications for commercial logging and sleeper cutting. Another 900 ha (Lake Tala) is protected within the District but this is west of the lignum areas nominated by the DWR and is not included in Stage One of the management plan.

1.2 Areas protected by private agreement

Additional areas needing protection were discussed at the last Committee meeting. The DWR was to negotiate with landholders for voluntary agreements to protect some of these areas (Figure 1), with the following result :

Area 1 : successful negotiations to protect a 40m band of lignum around floodrunners, to maintain vegetative continuity between Protected Lands.

Area 2 : Negotiations unsuccessful. No further action will be pursued by DWR because the already protected portion behind Suicide Bank is quite large and the additional area is seen as non-essential in terms of the overall protected area . Other Departments on the Committee may wish to make representations to the landholder and/or CAP Board for this area to be protected.

Area 3 : Not negotiated. Negotiations were to be considered if those on Area 5 were unsuccessful. This area was cleared prior to negotiations on Area 5.

Area 4 : Not negotiated. The committee agreed that no further protection was needed.

Area 5 : Negotiations unsuccessful. Over half this area is now cleared. This area was desired as food habitat support for possible breeding populations in nearby rookeries, notably Littlewood.

Area 6a : Successful negotiations for a wildlife corridor.

Area 6b : Successful negotiations for a wildlife corridor.

Area 7 : Successful negotiations for a buffer zone.

1.3 Conditions operating in Protected Land

Generally, all the Committee's recommendations were incorporated in the Conditions and Guidelines issued by CAP Board (attached behind). These are standard Conditions which will be attached to most clearing authorities, and the Guidelines are provided to assist inspecting officers.

However, the Committee's recommendation of no chaining in "special habitats" is not included as a standard condition as requested. These "special habitats" (i.e. rookeries and woodlands, Figure 2) are sub-categories identified by the DWR, not official CAP Board categories.

Guideline no. 4 allows inspectors to recommend that the CAP Board add a special condition on relevant permits for no chaining in these areas. The CAP Board Executive did not accept a requested modification of Guideline 4 to further support this no chaining condition. The Board has advised that the modification will be considered in any future review of the Guidelines.

1.4 Inspections

As indicated above, clearing applications will be received and inspected by the DWR for Protected Land under the categories of Habitat Protection and Prescribed Streams and Lakes (excluding SCS responsibilities).

Joint inspections between NPWS and DWR, when considered necessary, will be undertaken by regional officers. The DWR will provide further information for inspectors on Protected Land accompanied by maps showing the location of special habitat areas.

The SCS will deal with applications for commercial logging and sleeper cutting on Prescribed Streams and Lakes.

Inspectors will recommend to the CAP Board on each application:

- (i) Whether to grant a clearing authority
- (ii) Which conditions to attach to the authority. Inspectors may recommend special conditions in addition to the standard ones.

The CAP Board will consider these recommendations in making any final decision on authorities.

1.5 Applications recieved

Apparently, one application for clearing was received in June 1988, and was inspected by Mr Junor (SCS Commissioner). This clearing was approved by Mr Junor, and was in an area of lignum interspersed with Black Box in the western part of the Protected Lands. This was prior to the final proclamation of Protected Lands (August 1988), in an area which was not considered essential to protect.

It is envisaged that further applications may be received in the near future for clearing within some floodway areas, as some landholders are prepared to crop these areas at the risk of flood damage.

1.6 CAP Board visit to Lowbidgee (April 1989)

The CAP Board, on its annual field inspection, visited the Lowbidgee area on 7th April 1989 for an aerial inspection and to discuss issues affecting the lignum wetlands. The Board also visited the Balranald area, erosion hazard areas to the north, and the Great Cumbung Swamp.

1.7 Breach of Protected Lands

About early April 1989 an area of lignum was ploughed, contrary to Condition no. 5, in anticipation of the recent floods. The CAP Board is aware of this and the DWR is investigating the breach.

2 Development of the Management Plan

The development of the plan is proceeding. The DWR's floodway design has been modified substantially to incorporate environmental needs.

2.1 Aims

The Plan's general objectives conform with the Department's corporate objectives, and include :

- to protect and enhance the aquatic and related environment
- to share water among 'users' in ways which achieve the best balance between economic equity, the environment and sustained land use.

2.2 Stages

The Plan is being developed in two stages. The Stage One Plan is currently being reviewed internally and it is anticipated that it will be released in July 1989. It represents the achievements to date in progressing the management of the study area.

The Stage One document, some 60 pages, consists of four parts :

- Part A - Introduction
- Part B - Protected Lands and private agreements
- Part C - Floodway Scheme (as modified)
- Part D - Outline of Stage Two of the Management Plan. Objectives (general and specific), wider issues of management, management zones and monitoring are detailed.

Stage Two, the integrated plan, will be released at a later date and will contain :

- Department responsibilities : legislation, policies and international agreements
- Objectives
- Land management strategy
- Water management strategy
- Management zones
- Monitoring
- Plan review

Public comment will be invited on Stages One and Two. Stage One components have undergone extensive consultation, review and agreements, and any modifications that will be considered will primarily relate to the floodway scheme. Minor floodway realignments will be considered providing they do not impinge on any areas of Protected Land or private protection.

2.3 Steering Committee Recommendations

During the development of the Plan, other previous recommendations will be considered :

- Monitoring - jointly with NPWS and possibly others.
 - including the use of rookery areas by waterbirds and the response of lignum to chaining and clearing.

- remote sensing : aerial photography at 1:25,000 and LANDSAT imagery has been done, and may be calibrated to determine the best method.

- Others
- address the issue of additional transverse banks across creeks.
 - management plan to operate on a co-operative basis with landholders.

3 Steering Committee Involvement

At this stage it is not considered necessary to convene a meeting of the Committee. Member organisations on the Committee will be sent a copy of the Stage One Plan immediately prior to public release. There will be opportunity for members to review and comment on the Plan and these views will be taken into account for the Stage Two Plan. It is intended that a Committee meeting be convened shortly after the release of Stage One.

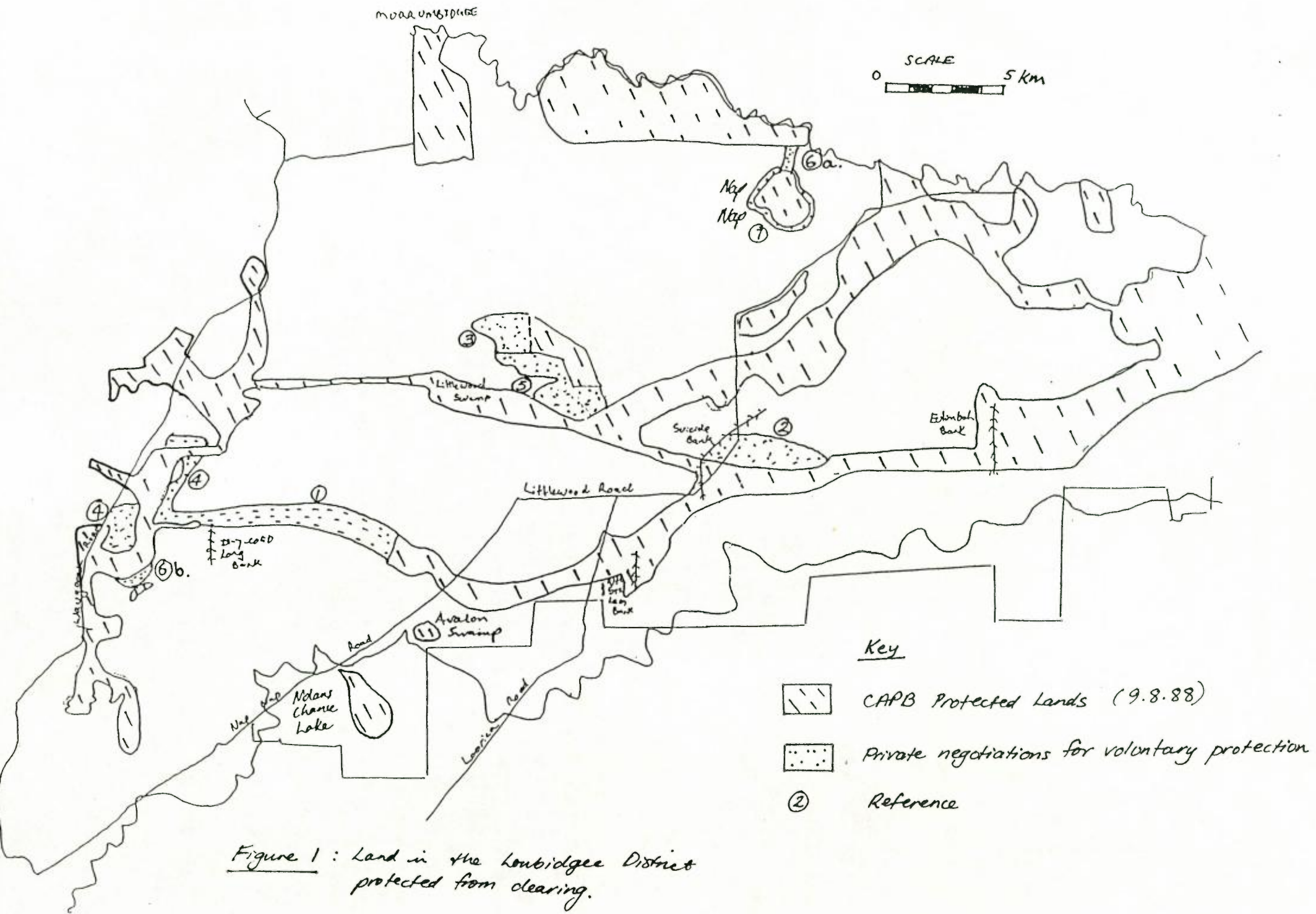


Figure 1: Land in the Loubidgee District protected from clearing.

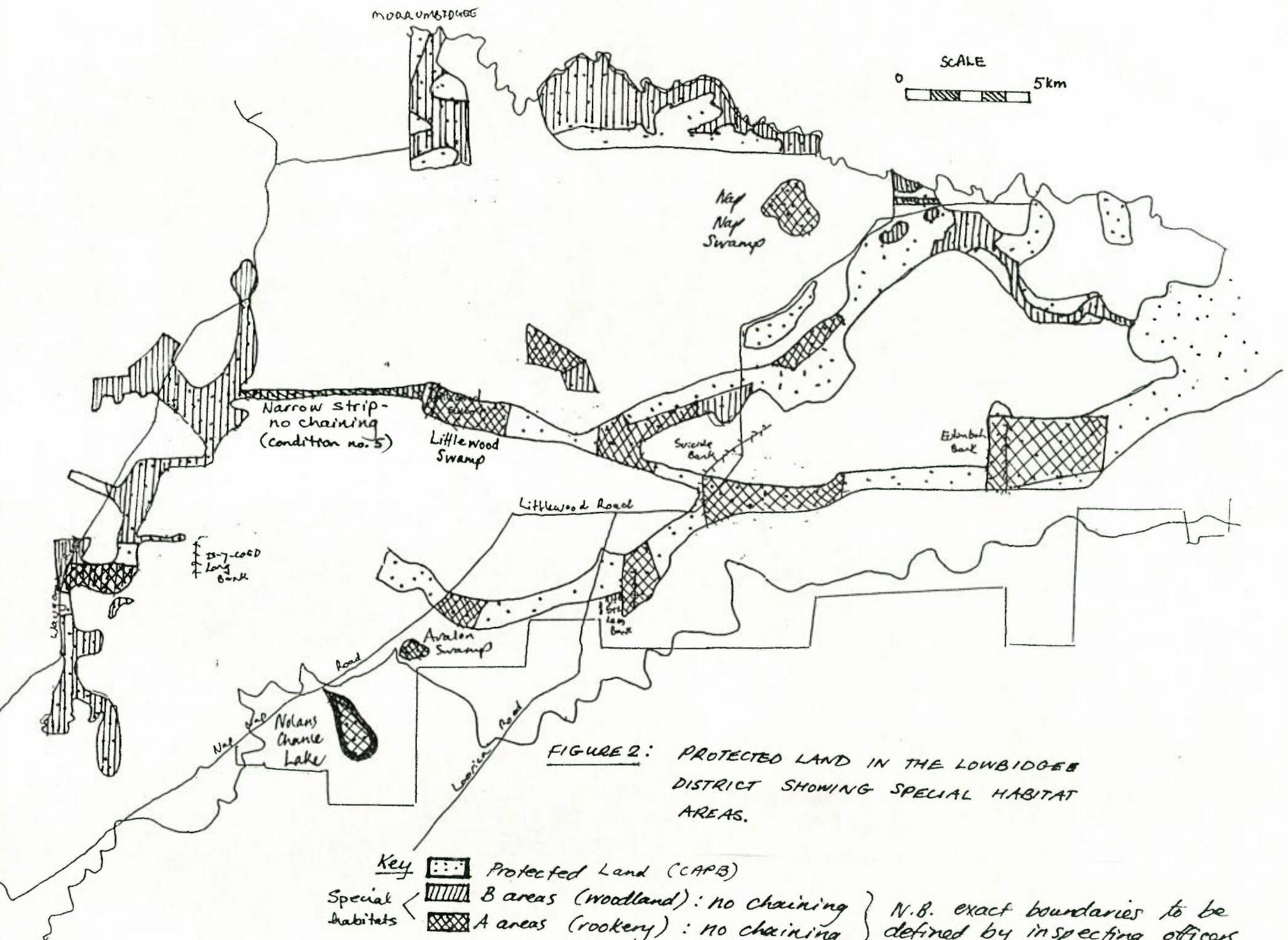


FIGURE 2: PROTECTED LAND IN THE LOWBIDGEES DISTRICT SHOWING SPECIAL HABITAT AREAS.

CATCHMENT AREAS PROTECTION BOARD

STANDARD CONDITIONS FOR AUTHORITIES ISSUED IN RESPECT OF VEGETATION ON PROTECTED LAND IN THE LOWBIDGEE

1. Except where clearing is authorised and consistent with these conditions, vegetation shall not be chained in both directions.
2. Chaining of lignum shall not occur over an area greater than 20% of the protected land within each Holding Reference in any one year or over any particular area more frequently than once in five years during the period of this authority.
3. Adjacent areas shall not be chained in consecutive years. A separation of at least 100 metres shall be maintained between consecutive chaining areas.
4. Chaining shall not occur within 40 metres of the outer banks of major runners.
5. Chaining shall not occur where the width of lignum through protected land is less than 200 metres.
6. Clearing for stock corridors shall not exceed 6 metres in width and at a frequency of no more than one each 500 metres.
7. Vegetation or debris shall not be burned on protected land.
8. Clearing for firebreaks shall not exceed 10 metres in width.
9. Clearing for fence lines shall not exceed 6 metres in width for a boundary fence and 5 metres in width for an internal fence.
10. Clearing for dedicated roads shall not exceed 20 metres in width and for private roads shall not exceed 4 metres in width.
11. Clearing for construction of diversion banks and channels shall not exceed a width of metres.
12. Clearing for maintenance of diversion banks and channels shall not exceed 10 metres in width.
13. Clearing to reduce fire hazard shall not extend more than 100 m from the building to be protected.

**GUIDELINES FOR CONSIDERING APPLICATIONS TO DAMAGE/DESTROY
VEGETATION WITHIN PROTECTED LAND IN THE LOWBIDGEE**

- (1) Chaining in both directions is considered to be clearing.
- (2) Where practical, corridors for fence lines, firebreaks, roads and stock shall be concurrent.
- (3) Inspections in relation to clearing or chaining applications shall be carried out jointly by regional officers of the Department of Water Resources and the National Parks and Wildlife Service at their discretion. If the application relates to a rookery habitat area, a joint inspection must be carried out.
- (4) In special habitat areas it may be appropriate to recommend a special condition prohibiting chaining.
- (5) The eradication of noxious plants shall be subject to the standard CAP Board conditions, but may also involve consultation with the Department of Agriculture and Fisheries, Pastures Protection Board and Shire Council weeds inspector.
- (6) Applications for agro-forestry ventures on protected land must be accompanied by a management plan outlining the area, density, flood regime/irrigation method, harvesting details and other proposed management details.



Stressed Rivers Assessment Report

Region • Far West

Catchment • Far Western NSW Streams

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Map 5 – Far Western NSW Streams - Identified Conservation Values

Map 6 – Far Western NSW Streams - High Conservation Values

Map 7 -- Far Western NSW Streams - Full Development Management Classifications

1.0 INTRODUCTION

1.1 BACKGROUND

In mid 1997, the NSW Government announced a package of water reforms, which included the release of a discussion paper: *A Stressed Rivers Approach to the Management of Water Use in Unregulated Streams* (DLWC 1997). The paper investigated ways of addressing the problems on stressed unregulated rivers and ensuring future security of supply through a process of comprehensive planning and monitoring.

This report focuses on seven catchments that make up the Far Western NSW Streams. Six of the seven catchments are collectively referred to as the Intersecting Streams as they intersect the NSW / Queensland border. The major portion of the catchment of each of these streams is in Queensland. These are the Moonie, the Narran, the Culgoa, the Warrego, the Paroo, and the Bulloo. The seventh catchment, the Yanda, is situated to the east of the Darling River on the Cobar Peneplain and is wholly within NSW.

All of the Far Western NSW Streams are unregulated within NSW. Unregulated streams are those which do not have major rural dams and therefore most water users rely on natural flows for their water supplies. However, the flows in these rivers may be affected by town water supply or hydroelectric dams, weirs and diversions.

In the past, licences on unregulated streams have been issued without properly considering the impact on flow or the capacity of river flows to meet the demand. In addition, only limited information has been available on river flow patterns and with limited community knowledge of these important environmental issues, past methods of issuing licences tended to encourage expansion in water demands.

As a result, many areas have experienced an over use of water resources and increasing evidence of environmental stress during dry times. This is because when flows are low, the residual water provides an important refuge for aquatic plants and animals by maintaining pool levels and water quality, which typically diminishes as the flow reduces. Without

residual water flows the water in these unregulated streams warms up, leading to the faster breakdown of organic matter and a decrease in the levels of dissolved oxygen. Reducing or stopping flow as a result of water extraction will cause conditions to deteriorate more rapidly and for extended periods. This not only places plants and animals at risk, but also reduces their ability to recover after each drought period, especially if other environmental disturbances have reduced their resilience.

There is now more widespread acceptance of the need to review the way water is extracted and to implement measures to protect the riverine environment from other disturbances such as pollution, riverbank clearing, invasion of exotic species and in-channel obstructions. Ultimately these measures will ensure that the ongoing supply of water and other riverine amenities for towns, farms and industries is secured.

In each catchment environmental, economic, social and equity factors vary significantly. Therefore, common rules and actions across all streams could result in unnecessary hardship in some catchments or inadequate environmental protection in others. However, the resources and time required to evaluate each stream individually and develop appropriate management strategies would be substantial. The stressed rivers approach therefore allows for different priorities and policies depending on the individual circumstances of each catchment but within a consistent framework.

Under the stressed rivers approach, rivers are classified according to their assessed level of environmental stress (particularly hydrologic) and conservation value. This classification is subsequently used to guide both the management priorities and policies. These high priority catchments include:

- those where demand for water already equals or exceeds supply (hydrologic stress);
- those where the water environment is significantly degraded (environmental stress); and

- areas of particular natural environmental value (High Conservation Value).

The *Stressed Rivers Assessment Report - NSW State Summary* (DLWC 1998) provided a statewide summary of this initial analysis and classification. Further analysis of information for the Far Western NSW Streams, and more detailed information on each catchment, has been presented in this report.

In developing the stressed rivers assessment, a whole of government approach was undertaken. This included the Department of Land and Water Conservation (DLWC), the Environment Protection Authority (EPA), NSW Agriculture, the NSW National Parks and Wildlife Service (NPWS) and NSW Fisheries.

1.2 A CATCHMENT FOCUS

The stressed rivers classification has been based on a catchment analysis, as there are substantial variations in the hydrologic, environmental and water use characteristics across the seven Far Western NSW Streams. The boundaries for the seven catchments that make up the Far Western NSW Streams have been determined primarily on hydrologic grounds, but have also taken some account of such issues as social factors and existing infrastructure.

1.3 THE CLASSIFICATION CATEGORIES

The classification system separates catchments into nine categories (Figure 1) based on assessments of both current environmental and hydrologic stress. The illustration in Figure 1 provides some of the rationale underlying the different categories.

1.4 FUTURE RISK / FULL WATER USE DEVELOPMENT SCENARIO

The primary classification for each catchment is based upon estimates of current water usage and assessments of environmental health. Many catchments also have a substantial number of undeveloped water entitlements which, if activated, could significantly increase levels of hydrologic stress. In order to gauge the potential level of future hydrologic stress, each catchment has also been assessed using a full water use development scenario.

The greatest future risk issue for consideration for six of the seven Far Western NSW Streams is future water management in Queensland. There are important implications for water sharing between NSW and Queensland. Apart from the Bulloo, which is outside the Murray-Darling Basin, each river system studied in this report is subject to the Murray-Darling Basin Cap. In NSW this Cap has resulted in a halt to acceptance of applications for licences for new surface water entitlements and commitment to constrain overall water use to that consistent with 1993/94 levels of development. Queensland however, has commenced a Water Management Planning process for each Intersecting Streams catchment, including the Bulloo, which may result in recommendations to allow further diversions and licences for new entitlements. NSW will continue to provide its views on the Queensland proposals in the Condamine-Balonne (feeds into Culgoa and Narran systems), Moonie, Paroo, Warrego and Bulloo catchments. The Queensland Government has released the following documents for community comment: the *Draft Water Management Plan Moonie River Catchment May 2000*, *Draft Water Management Plan Warrego, Paroo, Bulloo and Nebine Catchments June 2000*, and the *Draft Water Allocation and Management Plan (Condamine-Balonne Basin) June 2000*. These documents have assisted in the assessment of current and future hydrologic stress due to diversions in Queensland.

1.5 RIVERS WITH IDENTIFIED CONSERVATION VALUES

The classification process has also attempted to identify all catchments that have special conservation value. This may relate to the presence of threatened species, high value species, high value wetlands, or high levels of biodiversity. Special conservation values may also reflect pristine or near pristine condition of the rivers.

While it would be expected that many low stressed rivers - which by their nature are largely undeveloped - would have special conservation values, some impacted rivers can also support valuable remnant habitats and

Figure 1: Matrix of Stress Classifications and Management Categories

	Low ENVIRONMENTAL STRESS	Medium ENVIRONMENTAL STRESS	High ENVIRONMENTAL STRESS
High PROPORTION OF WATER EXTRACTED	<p>CATEGORY U1</p> <p>Despite high levels of water extraction the river seems reasonably healthy. However, more detailed evaluation should be undertaken to confirm. It is also likely that conflict between users may be occurring during critical periods.</p>	<p>CATEGORY S3</p> <p>Water extraction is likely to be contributing to environmental stress.</p>	<p>CATEGORY S1</p> <p>Water extraction is likely to be contributing to environmental stress.</p>
Medium PROPORTION OF WATER EXTRACTED	<p>CATEGORY U2</p> <p>There is no indication of a problem and, therefore, such rivers would be a low priority for management action.</p>	<p>CATEGORY S4</p> <p>Water extraction may be contributing to environmental stress</p>	<p>CATEGORY S2</p> <p>Water extraction may be contributing to environmental stress.</p>
Low PROPORTION OF WATER EXTRACTED	<p>CATEGORY U4</p> <p>There is no indication of a problem and, therefore, such rivers would be a low priority for management action.</p>	<p>CATEGORY U3</p> <p>Environmental stress is likely to be due to factors other than water extraction and, as stress is not high, these rivers would be a low priority for management action</p>	<p>CATEGORY S5</p> <p>While environmental stress is likely to be due to factors other than water extraction, the high level of environmental stress means it is important to ensure extraction is not exacerbating the problem.</p>

Notes:

1. Dark shading indicates categories with high combined stress rating.
2. Lighter shading indicates categories with medium combined stress rating.
3. Absence of shading indicates categories with low combined stress rating.
4. U = unstressed (U1 – U4), S = stressed (S1 – S5).

species which have been lost from similar rivers elsewhere.

The identification of these values provides important information to the river management planning process. Many rivers have specific conservation values that need to be explicitly addressed in future management. A smaller number have been identified as having high overall conservation value which would justify a greater level of protection and management. These have been given a special classification as High Conservation Value (HCV) catchments. Additional catchments have been nominated for future consideration as HCV catchments (called potential HCV catchments in catchment report cards). The conservation values and classification of these catchments need to be given special consideration during the development of river management plans and they may also warrant priority for planning.

1.6 MANAGEMENT IMPLICATIONS OF THE CLASSIFICATION SCHEME

In response to degrading river health and following an audit on water usage, the Murray-Darling Basin Ministerial Council (MDBMC) placed a 'cap' on any further water diversions in the basin. Following this, the DLWC placed an embargo on acceptance of applications for new water entitlements on the unregulated rivers covered by this report.

The embargo meant new or existing users could only gain access to additional water entitlements through water transfers. As a result, interim trading rules have been established in unregulated rivers (see *Water Sharing the Way Forward - Water Trading on Unregulated Rivers* [DLWC 1998] for details).

For all rivers in the Murray-Darling Basin embargoes on applications for new surface water entitlements will be retained. Once volumetric conversion of area based licences and river management plans are in place, water users will be able to trade entitlements in accordance with the local rules set by those plans and broader government policies.

1.6.1 Priority Setting for River Management Planning

High stressed (S1 to S3 categories - see Figure 1) and HCV catchments will be given priority in terms of resources and management. Catchments categorised as S4, S5 and U1 (see Figure 1) will be given medium priority. This approach will ensure that actions are taken according to the needs of the individual streams, and that the impact on the rural community is concentrated where it is likely to make a real difference to river health and water use opportunities.

The aim is to develop River Management Plans for stressed and HCV rivers as a priority. Plans for the remaining rivers will then be developed progressively.

These plans will address future water access rules and trading arrangements as well as water quality and river rehabilitation strategies for each catchment. They will be approved by both the Minister for Land and Water Conservation and the Minister for the Environment.

1.7 REVIEW AND MONITORING

All plans will include a set of performance criteria so that management can be reviewed and adjusted as necessary. As river management plans are developed, the classification of each stream will be reviewed using additional field data where appropriate. The DLWC has also been undertaking a survey of existing irrigation development as part of the volumetric conversion process and this information will also assist the initial review.

The Committees will also assist the government in determining an appropriate river monitoring strategy to enable the classification to be reviewed and performance monitored. A basic state-wide monitoring program to validate the classification aims to be implemented in the near future and a pilot study is under way.

A major review of the plans will occur every five years. If an unstressed stream is later classified as stressed or a stressed stream is not improving, a careful evaluation of the

adequacy of management action would be necessary to determine if alternative actions are justified. Conversely, additional field data and/or rehabilitation actions of a river management plan may lead to a catchment moving from a high to lower stress category (see Figure 1). In such cases, it is possible that less stringent water access and trading rules could be included in the update of the river management plan, providing this did not conflict with Cap management targets.

1.8 THE OUTCOMES OF THE STRESSED RIVERS APPROACH

The intention of the stressed rivers approach is to provide three outcomes:

- categorisation of each catchment as high stressed (S1 – S3), medium stressed (S4, S5 or U1) or low stressed (U2 - U4) and identification of HCVs for the implementation of the interim trading rules on unregulated streams;
- list of catchments in order of priority for river management planning. The ranking would be determined by stress classification, conservation values, full development management classification and future risk considerations; and
- baseline information on environmental indicators and hydrologic condition of each individual catchment as a guideline for future planning activities.

It is important to recognise that the initial stressed rivers process was designed to provide a rapid analysis of unregulated catchments. This was carried out by regional scientists and technical experts drawing on existing information and aerial photography, with expert panels from the DLWC, EPA, NSW Agriculture and NSW Fisheries checking environmental stress, hydrologic stress and future risk rating for each catchment. This report presents the findings of these assessments.

Although this process excluded additional data collection and extensive field verification, it is based on the best readily available information and provides a sound basis from which interim management decisions may be made and expanded upon. More detailed investigation will occur at the river management planning

stage, using the stressed rivers assessment as a guide.

2.0 METHODS

The stressed rivers assessment was undertaken in six steps:

- Selection of catchment and mapping boundaries;
- Determination of hydrologic stress of each catchment;
- Compilation of evidence of environmental stress;
- Identification of conservation value;
- Assessment of flow impacts of full development of existing water licences; and
- Overall stress classification.

2.1 SELECTION OF CATCHMENT BOUNDARIES

In general, the boundaries of catchments were defined on a hydrologic basis. When defining the boundaries, consideration was also given to geology, terrain, social groupings of the area (eg., government or water user group boundaries, more catchments in intensive landuse areas), stream gauging and major water quality sampling points.

Initial breakdown was completed on 1:100,000 topographical maps then reviewed by both DLWC catchment teams and later by various water users and water sub-committees of the region's Catchment Management Committees (CMCs).

For the purposes of the Stressed Rivers Assessment, the Far West region was divided into seven catchment management units, and named the Far Western NSW Streams. Unlike Stressed River Assessments throughout the remainder of NSW, it was not necessary to divide catchments into subcatchment units as each catchment already satisfied the following criteria:

- the boundaries must be hydrologically based;

- geology, terrain and slope changes (tablelands / gorge / valley) must be considered;
- the boundaries must attempt to reflect natural social groupings in a particular catchment; and
- the boundaries must, where possible, coincide with stream gauging and major water quality sampling points.

Each Far Western catchment was named based on the main watercourse for that catchment.

2.2. HYDROLOGIC STRESS

2.2.1 Expert Panel Assessment

The nature of river flows in Far Western NSW differ markedly from those in other parts of the State. Apart from the Barwon-Darling river system's main channel, all the watercourses in the studied catchments have episodic, highly variable flow patterns. Many streams cease to flow over 50% of the time, including the Warrego, Birrie and Narran Rivers (Anon, 1997). Annual streamflow is highly variable with recorded annual discharges of 800% to less than 5% of the mean of recorded flows. Averages disguise this huge annual and seasonal variation.

The criteria used throughout the remainder of the state, which included 80th and 50th percentile flows being compared to water extraction during peak usage months, proved more applicable to regular flowing streams. Considering the unique characteristics of river flow in this area, the standard Stressed Rivers criteria for assessing hydrologic stress was inappropriate.

To overcome this problem, and the lack of data available in the region, a DLWC panel with knowledge of local area stream flows and water usage was used to assess the catchments and assign a high, medium or low hydrologic stress classification to each.

The Far Western NSW Streams regional expert panel consisted of regional licensing officers, hydrologists and other staff involved in the Stressed Rivers Assessment project. The panel considered issues such as the number of current and sleeper water licences; past, present and future water extraction activity; and the nature of water use and current landuse activities in each of the seven catchments.

It should be noted that the hydrologic stress of each catchment was assessed both including and excluding Queensland water extraction. This was done to see whether NSW extractions on their own were contributing substantially to stress on these systems and how significant they were relative to the impacts of Queensland's usage. For this report, the combined impact of usage by NSW and Queensland was adopted as the overall hydrologic stress. Similarly, this occurred within the full development assessment of hydrologic stress.

2.2.2 Identification of Unregulated Licences

The identification of unregulated licences in each catchment of the Far Western NSW Streams was determined by manually identifying catchment codes that apply to each catchment area and then extracting the relevant licences from the Licensing Administration System (LAS) database.

Queensland water licence information was supplied by the Department of Natural Resources and extracted from the Water Entitlements Registration Database (WERD).

2.3 EVIDENCE OF ENVIRONMENTAL STRESS

To enable a 'relative comparison' between catchments it was important to have environmental indicator measures available across the catchments. The indicators used for the Far Western NSW Streams are outlined in Table 1 below.

2.3.1 Stream Health Indicators

Table 1: Indicators Used to Determine Environmental Stress for the Far Western NSW Streams

Indicator Category	Main Considerations
Geomorphology	<ul style="list-style-type: none"> bank stability, indicator expressed as percent stream length with visible bank erosion bed condition, identification of catchments with significant bed instabilities
Structures/Barriers Inhibiting Fish Passage	<ul style="list-style-type: none"> presence of dams in the catchment presence of weirs and barrages presence and influence of barriers to fish passage
Water Quality	<ul style="list-style-type: none"> <i>Physical and chemical</i>: total phosphorous, turbidity, electrical conductivity/ salinity and acidity/ alkalinity (pH) <i>biological</i>: macroinvertebrate survey results (AUSRIVAS - Australian River Assessment Scheme)
Gully Erosion	<ul style="list-style-type: none"> gully erosion, indicator expressed as proportion of land in each catchment affected by gully erosion

The databases used for each indicator were for New South Wales only.

Bank and Bed Erosion (Geomorphology):

Geomorphology was chosen as an indicator of stress because of the availability of data and its recognised influence on the amount of water available in pools during droughts. The loss of pool-riffle structure, which is important for habitat diversity and instream storage, has been used as a key indicator in a number of riverine health assessments (Ian Drummond and Associates [1985]; Anderson [1993]; Mitchell [1990]; Tilleard, [1986]).

Destabilised river geomorphology affects stream health by a number of processes. These include:

- the loss of pool-riffle sequences through deposition of fine grained sediments results in wider, shallower flows which are subject to greater temperature variations, an effect which is frequently compounded by loss of shading (see riparian vegetation);
- unstable beds reduce recruitment of aquatic macrophytes (water plants); and
- sedimentation of river beds by fine particles is associated with increased nutrient loads.

Three homogenous (Anderson, 1993) reaches within each identified broad landscape class were selected for each of the seven catchments. Random air photographs, which covered 20% of the identified areas, were selected. This sub-sample was used to determine the percentage of stream segments affected by loss of pool and riffle sequences, channel alteration (sediment slugs, channel widening etc.), or bank erosion. The percentage of photographs showing these effects/impacts were determined and then used to categorise the stress level using the criteria below.

Table 2: Geomorphological Thresholds for Aerial Photo Interpretation

Measure	Threshold	Stress
Percentage of stream segments affected by (a) loss of pool riffle sequence, (b) channel alteration, (c) bank erosion.	>50 %	High
	25 to 50%	Medium
	<25%	Low

Barriers Inhibiting Fish Passage

An assessment of the number and magnitude of structures which form barriers to fish migration is used to indicate stream condition. The effect of barriers on the migration of many species of Australian native fish is an important consideration in assessing stream health.

Weirs, causeways, culverts and other structures alter the geomorphology of the stream and can completely or partially block fish passage. This impairment to the migration of many species affects breeding and recruitment. Populations may become isolated and limited in genetic diversity.

Three main parameters have been used to assess the impact of barriers on fauna.

1. *The location of the structure.*

Structures on the higher order streams are regarded to be more problematic than those on tributaries because:

- most species have an estuarine or oceanic phase to their lifecycle;
- there are usually a greater abundance of species in the lower parts of catchments; and
- a greater proportion of the catchment is cut off from fish access.

2. *The type of the structure.*

Major problems with structures include:

- structures that create waterfalls are more difficult for fish to pass;
- structures that create high laminar (smooth, unmixed) flows or unnatural environments; and
- overhanging pipes and plunge pools.

3. *Size of the structure.*

- small weirs (<1 m high) may drown out during high flows but higher weirs rarely provide opportunity for fish passage; and
- small pipes are a greater problem than large pipes because flows achieve higher velocities. Pipes and culverts which create deep shade or darkness can also pose behavioural barriers to some fish species such as Bony Herring.

Location and number of structures

The location and number of structures in each catchment was determined from the DLWC's Weir Review Inventory. This information was used to categorise stress levels using the criteria below.

Table 3: Thresholds for the Numbers and Location of Fish Passage Barriers

Measure	Threshold	Stress
Location and number of structures.	≥1 structure on the main stream of catchment	High
	≥ 1 structure on a major tributary	Medium
	no structures or structures only present on minor tributaries	Low

Water Quality

The measurement of physical and chemical water properties provides an assessment of the suitability of the water to support life. Water quality planning is a major component of the Water Reforms. Further water quality assessment and data collection will be carried out under the strategies developed following the stressed rivers prioritisation project.

Available water quality data was summarised on a catchment basis along with information on the source and reliability of the data. For each water quality parameter, the available data sets were compared to water quality guidelines which are presented in Table 4.

Table 4: Guidelines for Far West Water Quality Assessment

Parameter (Units)	Guideline	Source
pH	6.5-9.0	ANZECC (1992)
Turbidity	< 50 NTU (nephelometric turbidity unit)	Bek & Robinson (1991)
Conductivity	< 800 μ S/cm (microsiemens per centimetre)	ANZECC (1992), adapted to local conditions
Total nitrogen	< 0.5 mg/L	ANZECC (1992), adapted to local conditions
Total phosphorus	< 0.10 mg/L	ANZECC (1992) adapted to local conditions

The median and the 75th percentile were calculated for each data set. These were used to provide an initial stress assessment to be made using a comparison with the guidelines in Table 4. The percentiles calculated correspond to the thresholds (Table 5) which distinguish high, medium and low stress.

Table 5: Water Quality Thresholds for the Raw Data Approach

Measure	Threshold	Stress
Percentage of observations that conformed with the guidelines outlined in Table 4.	< 50%	High
	50 to 75%	Medium
	> 75%	Low

Gully Erosion

Gully erosion is the removal of soil by running water, resulting in the formation of channels sufficiently large that they disrupt normal farming operations and are too large to be filled during normal cultivation. Gullies initiate when equilibrium within a minor drainage line is upset either by increased discharge or decreased soil resistance to detachment and transport (Charman and Murphy, 1991).

Information on the extent of gully erosion in the Western Division was taken from the Land Degradation Survey published by the Soil Conservation Service in 1989. The Land Degradation Survey was mapped from an analysis of regularly spaced sample points from a kilometre grid in the Western Division.

As part of the Stressed Rivers Assessment, the proportion of land in each catchment affected by gully erosion was compared. Two categories of gully erosion were identified: minor/moderate and very severe. The extent of each category in the seven catchments was scaled (minor/moderate % x 1.5; very severe % x 4), totalled, and rated (0-20 Low, 20-50 Medium, 50+ High) (Kerle, unpublished).

2.3.2 Environmental Stress Classification

Following the analysis of these indicators, an overall stress classification for each catchment was assigned. The environmental stress was determined using a decision tree method. If two-thirds of the stress classifications returned for each catchment were High, then the overall environmental stress was assessed to be **High**; where two-thirds of the stress classifications returned for each catchment were Low, the overall environmental stress classification was assessed to be **Low**. The remainder were classified as being of **Medium** environmental stress. As a precaution, the 'worst case' stress classification for each catchment was adopted.

2.4 HIGH CONSERVATION VALUE

Indicators of environmental value were developed and assessed by the NPWS and NSW Fisheries. On the basis of these data, the two agencies assigned either an environmental value, high conservation value or no identified conservation value to each catchment. The method is outlined below.

2.4.1 NPWS Assessment

The NPWS defined Conservation Value rivers as those catchments which support one or more of the following:

- wetlands recorded under the RAMSAR Directory of Significant Wetlands, the Directory of Important Wetlands in Australia, SEPP 14 and REP 20;
- extensive riparian vegetation;
- total number of wetlands and the proportional area of wetlands;
- significant areas reserved in or identified as national parks, nature reserves or wilderness;
- significant areas of undisturbed rivers as identified by the Australia Heritage Commission's River Disturbance Index;
- presence of significant waterbirds; and

- presence of threatened species recognised by the International Union for the Conservation of Nature (IUCN).

Cultural considerations were not taken into account due to time constraints, but will be addressed as part of the river management planning process.

2.4.2 NSW Fisheries Assessment

The NSW Fisheries approach to the assessment of conservation catchments was based wholly upon the known or expected distribution of both native and alien fish within the catchment.

The known or expected presence or absence of fish species within catchments was recorded according to the following categories:

- known to be present from recent sampling or observations;
- expected to be present based on knowledge of species natural history including habitat preferences and altitudinal range, habitat conditions within catchment, and extrapolation from nearby known occurrences;
- expected to occur but excluded by an artificial barrier;
- expected to occur but excluded by a water quality barrier;
- introduced into catchment and now self sustaining population (for native species only); and
- regularly stocked into catchment to maintain populations.

Conservation Value Criteria 1:

Total number of species for each catchment exceeded average number of species for each basin.

Conservation Value Criteria 2:

Presence of threatened species, including Trout Cod, Eastern Cod and Oxleyan Pigmy Perch listed on the schedules of the Fisheries Management Amendment Act 1997.

Conservation Value Criteria 3:

Absence of alien species.

If one or more of the Conservation Value criteria were satisfied the catchment would be classed in the **Identified** Conservation Value category.

2.5 FULL DEVELOPMENT / FUTURE RISK CONSIDERATIONS

Primarily this assessment considered a full water use development scenario in order to gauge the potential level of future hydrologic stress. Once again, due to the unique nature of the region and a lack of reliable data, the expert panel assessed this level of stress, with the emphasis placed on the full development of all existing water licences in the region.

2.6 OVERALL STRESS CLASSIFICATION

The hydrologic and the environmental stress ranking were combined using the stress classification matrix (see Figure 1) to create a final category of stress for a subcatchment.

3.0 FAR WESTERN NSW STREAMS REGION DESCRIPTION**3.1 CONTEXT**

The DLWC's Far West region covers 42% of NSW. The region borders Queensland, South Australia and Victoria and includes the townships of Bourke, Wilcannia, Cobar, Broken Hill, Wentworth, Tibooburra, Walgett and Menindee. Situated within the Murray-Darling Basin, the region's eastern boundary includes the Barwon River from Mungindi to its junction with Marra Creek; and the Lachlan River between Condobolin and Lake Cargelligo, south west to the Murrumbidgee and Murray Rivers. The region also includes the NSW sections of the Intersecting Streams that arise in Queensland and enter the Barwon-Darling River to the west of Mungindi (see Appendix 1: Map 1 - Far Western NSW Streams Catchments).

The rivers of the seven catchments are naturally ephemeral, ie. they do not flow all the time. The Warrego, Birrie and Narran Rivers, for example, cease to flow more than 50% of the time (Anon, 1997). Research of Australian inland river systems indicates that maintenance of a drying phase is critical to maintaining the health and productivity of ephemeral streams. However, there is concern that high water use at times of low flow may place these systems under greater stress and cause them to dry out more often, more quickly and for longer periods than they would have under natural conditions.

Six of the seven Far Western NSW catchments occupy an area of northern NSW which lies within the Murray-Darling Basin. Covering 1,061,469 km², the Murray-Darling Basin is defined by the catchment areas of the Murray and Darling Rivers and their many tributaries. It extends over three-quarters of New South Wales, more than half of Victoria, significant portions of Queensland and South Australia, and includes the whole of the Australian Capital Territory (Crabb, 1997). The Far Western NSW catchments within this area are tributaries of the Barwon-Darling river system, with the majority of river flows originating in Queensland. The NSW portion of these catchments represents 13% of the Murray-Darling Basin. The remaining catchment (Bulloo) falls within the Bulloo-Bancannia catchment, immediately west of the Murray-Darling Basin. The NSW section of the Bulloo catchment does not drain into any river (EPA, 1997).

Despite the expanse of catchments being studied, the catchments are all in the hot, semi-arid region of NSW, having similar climatic characteristics. The mean daily maximum temperature in January is 36°C and mean daily minimum for July is between 3 - 6°C. The median rainfall for the catchments varies between 200 - 500 mm and on average, large flood events occur every five years, while small/medium flood events, more frequently.

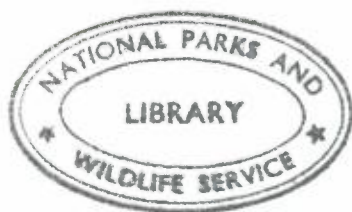
Additional characteristics for each catchment are described below in Table 6.

Table 6: Far Western NSW Streams Statistics

	Bulloo		Culgoa ¹		Moonie		Narran		Paroo		Warrego		Yanda
NSW Catchment Area (km²)	20,393		11,824		745		14,003		40,451		11,375		42,052
Water Use²	<i>QLD</i>	<i>NSW</i>	<i>QLD⁴</i>	<i>NSW</i>	<i>QLD</i>	<i>NSW</i>	<i>QLD⁴</i>	<i>NSW</i>	<i>QLD</i>	<i>NSW</i>	<i>QLD</i>	<i>NSW</i>	<i>NSW</i>
Licensed Pumps	5	0	81	17	74	4	8	18	7	4	96	12	0
Licensed Storages³	4	0	22	8	44	0	5	8	1	1	56	14	9
Licensed Diversion Channels	2	0	6	0	4	2	3	3	0	1	3	4	0
Authorised Irrigation Area (Ha) (NSW)	0		628		174.5		1,364.5		51		2,679.5		0
Geology	<ul style="list-style-type: none"> • <i>Moonie, Narran, Culgoa, Warrego, Paroo</i> - Quaternary unconsolidated sediments. • <i>Bulloo</i> - Mesozoic bedrock, consolidated, horizontally bedded. • <i>Yanda</i> - Palaeozoic & Pre-Cambrian. Igneous rock and deformed sediment. 												
Landuse	<ul style="list-style-type: none"> • Grazing – sheep for wool, beef cattle. • Dryland and irrigated agriculture - wheat, sorghum, sunflowers and cotton. 												
Tenure	Primarily leasehold under the Western Lands Act, 1901.												

Footnotes:

1. Includes Birrie and Bokhara Rivers
2. Numbers of licences to divert water (either through river pumps or diversion channels) or which otherwise affect flows (instream storages) are given for NSW and Queensland. Not all works are installed and many licences are currently inactive.
3. Instream storages only.
4. From Bifurcation No. 1 to NSW border only



4.0 CATCHMENT RESULTS

4.1 CLASSIFICATION MATRIX

Total Number of Catchments	7
Number Unclassified	0
Number Classified	7

4.1.1 Current Water Use and Development

Figure 2: Matrix of stress classification showing catchments in different stress categories based on current levels of water extraction (including Queensland development) – See also Table 8.

HYDROLOGIC STRESS	LOW ENVIRONMENTAL STRESS	MEDIUM ENVIRONMENTAL STRESS	HIGH ENVIRONMENTAL STRESS
HIGH EXTRACTION	U1	S3 Culgoa Narran	S1
MEDIUM EXTRACTION	U2	S4 Warrego Moonie	S2
LOW EXTRACTION	U4 Bulloo Yanda Creek	U3 Paroo	S5

Adopting the planning priorities proposed would result in:

- Two catchments of high priority (S1, S2, S3) for the preparation of river management plans;
- Two catchment of medium priority (S4, S5, U1) for the preparation of river management plans; &
- Three catchments of low priority (U2, U3, U4) for the preparation of river management plans.

These catchments are mapped in Appendix 1: Map 2 - Far Western NSW Streams Current Management Classifications.

4.1.2 Full Water Use Development Classifications

Consideration of future risk, specifically the activation of all existing water licences, would change the numbers in each category as shown in Figure 3.

Figure 3: Matrix showing catchments in different categories based on full development of water licences (including Queensland development) – See also Table 11.

HYDROLOGIC STRESS	LOW ENVIRONMENTAL STRESS	MEDIUM ENVIRONMENTAL STRESS	HIGH ENVIRONMENTAL STRESS
HIGH EXTRACTION	U1	S3 Culgoa Narran Moonie	S1
MEDIUM EXTRACTION	U2	S4 Warrego	S2
LOW EXTRACTION	U4 Bulloo Yanda Creek	U3 Paroo	S5

Adopting the full development scenario as a basis for planning priorities would result in:

- Three catchments of high priority (S1, S2, S3) for the preparation of river management plans;
- One catchment of medium priority (S4, S5, U1) for the preparation of a river management plan;
- Three catchments of low priority (U2, U3, U4) for the preparation of river management plans.

These catchments are mapped in Appendix 1: Map 7 - Far Western NSW Streams Full Development Management Classifications.

4.1.3 Identified Conservation Value

- Seven catchments have been identified by NPWS and/or NSW Fisheries as having specific conservation values.
- Six catchments have been identified by the NPWS as having specific conservation values.
- Seven catchments have been identified by NSW Fisheries as having specific conservation values.

These conservation values will be factored into the river management plans where specific conservation strategies may be necessary.

These catchments are mapped in Appendix 1: Map 5 - Far Western NSW Streams Identified Conservation Value Catchments.

4.1.4 High Conservation Value

- Five catchments have been identified by NPWS and NSW Fisheries as being of High Conservation Value (see Table 7 and Appendix 1: Map 6 - Far Western NSW Streams High Conservation Value Catchments).

Table 7: High Conservation Value Catchments

Catchment	Subcatchment	Overall Stress Classification
Far West	Culgoa	S3
	Narran	S3
	Paroo	U3
	Warrego	S4
	Yanda	U4

Potential High Conservation Value

Further desktop analysis indicated that two additional catchments may also be HCV catchments. River management committees will be required to explicitly review and consider the conservation value of these catchments during plan preparation.

4.2 STRESS CLASSIFICATIONS

4.2.1 Stress Classifications Summary – Current Water Use and Development

Table 8: Summary Table of Stress Classifications for Catchments

Catchment	Current Management Classification (NSW water use only)	Current Management Classification (including Qld water use)	Hydro. Stress (NSW water use only)	Hydro. Stress (including Qld water use)	Enviro. Stress	High Conserv. Value	Identified Conservation Value	
							NPWS	Fisheries
Bulloo	U4	U4	Low	Low	Low	*	Yes	Yes
Culgoa	U3	S3	Low	High	Medium	Yes	Yes	Yes
Moonie	U3	S4	Low	Medium	Medium	*	No	Yes
Narran	U3	S3	Low	High	Medium	Yes	Yes	Yes
Paroo	U3	U3	Low	Low	Medium	Yes	Yes	Yes
Warrego	S4	S4	Medium	Medium	Medium	Yes	Yes	Yes
Yanda	U4	U4	Low	N/A	Low	Yes	Yes	Yes

Note:

1. N/A indicates that the catchment does not extend to Queensland.
2. * refers to a potential HCV catchment.
3. The overall hydrologic stress used in the classification of subcatchments and the formation of subsequent maps was the stress value that included Queensland water use.

For maps of current stress classifications see Appendix 1: Map 2 - Far Western NSW Streams Current Management Classifications; Map 3 - Far Western NSW Streams Hydrologic Stress; and Map 4 - Far Western NSW Streams Environmental Stress.

4.2.2 Environmental Stress

Table 9: Stream Condition Assessment – Desktop assessment

Catchment	Area (km ²)	% of Study Area	Fish Barriers	Bank Condition	Water Quality	Gully Erosion	Environmental Stress
Bulloo	20,393	14.49	Low	Low	Low	Low	Low
Culgoa	11,824	8.40	High	Low	High	Low	Medium
Moonie	745	0.53	Low	Med	Low	Low	Low
Narran	14,003	9.94	High	Med	High	Low	Medium
Paroo	40,451	28.72	High	Low	High	Low	Medium
Warrego	11,375	8.07	High	Low	High	Low	Medium
Yanda	42,052	29.85	High	Low	Low	Low	Medium

Table 10: Environmental Stress

Catchment	Desktop Stress Assessment	Expert Panel Assessment	Adopted Stress Classification
Bulloo	Low	Low	Low
Culgoa	Medium	Medium	Medium
Moonie	Low	Medium	Medium
Narran	Medium	Medium	Medium
Paroo	Medium	Medium	Medium
Warrego	Medium	Medium	Medium
Yanda	Medium	Low	Low

* The adopted stress classification may have altered where the desktop assessment conflicted with the expert panel and regional knowledge for a catchment. For example, the overall environmental stress assessment is low for Yanda as the impact of numerous fish barriers is negated by the ephemeral nature of the flow regime in the catchment.

4.2.3 Full Development Classifications

Table 11: Full Development Management Categories

Catchment	Full Water Use Development Management Classification (NSW water use only)	Full Water Use Development Management Classification (including Qld water use)	Hydrologic Stress: Full Development Scenario (NSW water use only)	Hydrologic Stress: Full Development Scenario (including Qld water use)	Current Environmental Stress
Bulloo	U4	U4	Low	Low	Low
Culgoa	S4	S3	Medium	High	Medium
Moonie	S4	S3	Medium	High	Medium
Narran	S3	S3	High	High	Medium
Paroo	U3	U3	Low	Low	Medium
Warrego	S4	S4	Medium	Medium	Medium
Yanda	U4	U4	Low	N/A	Low

4. N/A indicates that the catchment does not extend to Queensland.

5.0 CATCHMENT RESULTS – REPORT CARDS

5.1 BULLOO

Catchment: Bulloo
 Stream: Bulloo River and Overflow
 Current Management Category: U4 (NSW and QLD diversions)

	Low Env. Stress	Medium Env. Stress	High Env. Stress
High Extraction			
Medium Extraction			
Low Extraction	✓		

Environmental Stress Indicators:

- For the *fish barriers* indicator, no data were available to suggest the presence of fish barriers. The overall rating for this indicator was determined to be **low**.
- For the *bank condition* indicator, the representative study area did not show channel alteration or bank erosion. The overall rating for this indicator was determined to be **low**.
- For the *water quality* indicator, no records were available to assess the condition of the water body. The overall rating for this indicator was determined to be **low**.
- For the *gully erosion* indicator, 9% of the catchment was moderately affected. The overall rating for this indicator was determined to be **low**.

Primary Stress Factors:

1. Wind erosion.
2. Feral animal invasion (Total Grazing Pressure).

High Conservation Value: Possible High Conservation catchment. Conservation status to be reviewed by River Management Committee.

Identified Conservation Value:

NPWS Yes NSW Fisheries Yes

Justification

- Significant wetlands which are listed in the Directory of Important Wetlands.

Justification

- High species diversity.
- Relatively undisturbed fish populations.
- Relatively low alien fish populations.

Future Risk Considerations:

- Future water diversions on the Bulloo River in Queensland – subject to the finalisation of the water Management Plan. See *Draft Water Management Plan Warrego, Paroo, Bulloo and Nebine Catchments June 2000*.
- Invasion of annual exotic grasses.

SUBCATCHMENT DESCRIPTION	
Area (NSW):	20,393 km ²
Land Systems Information (NSW):	37 land systems in the catchment 20% of catchment floodplains and related land systems
Tenure (NSW):	Primarily leasehold under the Western Lands Act, 1901
No. of Licensed Works ¹ :	QLD: 5 pumps; 4 storages; 2 diversion channels. NSW: 0 works

¹ Licensed works may be for irrigation, stock and domestic water supply, town water supply, water harvesting and industrial purposes.

Bio-regional Classification:

- **Channel Country:** 50% of catchment in NSW. Low hills on Cretaceous sediments; forbfields and Mitchell grass downs, and intervening braided river systems of *coolibah*. *coolibah* woodlands and lignum/saltbush *Muehlenbeckia* sp./*Chenopodium* sp. shrublands. Includes small areas of sandplains.
- **Mulga Lands:** eastern quarter of the catchment. Undulating plains and low hills on Cainozoic sediments; red earths and lithosols; *Acacia aneura* low woodlands and shrublands.
- **Simpson - Strzelecki Dunefields:** Occurs as a corridor between the Channel Country and Mulga Lands and on the western edge of the catchment. Arid dunefields and sandplains with sparse shrubland and spinifex hummock grassland, and cane grass on deep sands along dune crests.

Flora and Fauna Associations:

- Grey grasswren (*Amytornis barbatus*), which occurs in the lignum of the Bulloo Overflow, is an example of a species with a very restricted distribution.

Major Land Systems¹ (% of catchment and brief description)	
Waverley (Wv)	16% Broadly undulating sandplain with mulga.
Reola (Re)	15% Level to slightly undulating sandplains between the Paroo and the Bulloo.
Gumpopla (Gp)	11% Sand dunes alternating with flats and pans, occupying extensive areas adjacent to the Bulloo Overflow.
Bullagree (Bu)	7% Evaporites of the Bulloo Overflow.
Olive Downs (Od)	6% Undulating stony country with gilgais etc.
Teurika (Tu)	6% Littoral zones and delta fans associated with the Bulloo Overflow.
Pulgamurtie (Pg)	4% Rolling stony uplands with breakaways.
Tongowoko (To)	4% Relict lunettes and backpans of prior lakes.
Wonga (Wn)	4% Low dunes with scalded alluvial flats and isolated pans.
Colane (Ce)	4% Broad alluvial plains with regular small depressions away from channel zone.

¹ Land systems may not total 100 per cent as only *major* systems have been listed.

5.2 CULGOA

Catchment: Culgoa
Stream: Culgoa, Bokhara & Birrie Rivers
Current Management Category: S3 (NSW and QLD diversions)

	Low Env. Stress	Medium Env. Stress	High Env. Stress
High Extraction		✓	
Medium Extraction			
Low Extraction			

Environmental Stress Indicators:

- For the *fish barriers* indicator, a total of 20 barriers were identified; 11 not being considered significant to fish passage. The overall rating for this indicator was determined to be **high**.
- For the *bank condition* indicator, 21% of the representative study area was identified as having a degree of channel alteration or bank erosion. The overall rating for this indicator was determined to be **low**.
- For the *water quality* indicator, records showed that median electrical conductivity and pH levels were below ANZECC Guidelines, while total phosphorus, total nitrogen and turbidity results exceeded ANZECC Guidelines. The overall rating for this indicator was determined to be **high**.
- For the *gully erosion* indicator, low levels of moderate and severe gully erosion were detected (<3.4% of catchment area). The overall rating for this indicator was determined to be **low**.

Primary Stress Factors:

1. Water extraction.
2. Feral animals.

High Conservation Value: Yes

Identified Conservation Value:

NPWS Yes

NSW Fisheries Yes

Justification

- Balonne River.
- Bokhara River floodplain.

Justification

- High species diversity.
- Relatively undisturbed fish populations.
- Relatively low alien fish populations.

Future Risk Considerations:

- Queensland water extraction
- Floodplain and overland flow (off stream) developments
- Activation of sleeper licences

SUBCATCHMENT DESCRIPTION	
Area (NSW):	11,824 km ²
Land Systems Information (NSW):	27 land systems in the catchment 75% of catchment floodplains and related land systems
Tenure (NSW):	Primarily leasehold under the Western Lands Act, 1901
No. of Licensed Works¹:	QLD: 81 pumps, 22 storages, 6 diversion channels NSW: 17 pumps, 8 storages
Licensed Area (Irrigation)	628 Ha (within NSW)

¹ Licensed works may be for irrigation, stock and domestic water supply, town water supply, water harvesting and industrial purposes.

Bio-regional Classification:

- **Darling Riverine Plains:** 66% of the catchment in NSW. Alluvial fans and plains; summer/winter rainfall in catchment, including occasional cyclonic influence; grey clays; woodlands and open woodlands dominated by *Eucalyptus* Sp.
- **Mulga Lands:** One third of the catchment. Undulating plains and low hills on Cainozoic sediments; red earths and lithosols; *Acacia aneura* low woodlands and shrublands.

Flora and Fauna Associations:

- Floodplain associations cover 61.5% of the area and the remainder (38.5%) is defined as ‘red land’ - land which does not become inundated by floodwaters from the rivers. Of the 61.5% floodplain, 42% is open grassland, 11.5% woodlands, 2.5% lake beds and 5.5% is lignum. These proportions of vegetation associations differ between parts of the same catchment in NSW and Queensland.
- Floodplain woodland is composed of 47.5% coolibah, 9.5% red gum, 12.2% black box, 10.5% woody shrubs and 4.1% Acacias.

Major Land Systems¹ (% of catchment and brief description)	
Tatala (Ta)	11% Undulating sandhills on Barwon floodplain.
Myuna (Mv)	9% Plains with dense brigalow and/or gidgee along the Culgoa.
Dumble (Db)	8% Plains with broadly looping drainage channels.
Cartlands (Cs)	7% Extensive floodplains and stony plains of brown clays.
Pirillie (Pi)	6% Low rounded ridges of silicified sandstone and conglomerate.
Nidgery (Ni)	6% Floodplains of the Culgoa and Barwon.
Ellerslie (El)	5% Sandplains with clumps of brigalow and low dunes.
Goodooga (Gd)	5% Extensive Mitchell grass plains.
Rostella (Rs)	5% Scalded and floodplain country with minor drainage channels of the Barwon.
Upper Darling (Ud)	7% Tributaries of the Culgoa, Birrie, Bokhara, Narran & Bogan.
Wombeira (Wx)	5% Extensive highly channelised floodplains along the tributaries of the Barwon.

¹ Land systems may not total 100 per cent as only *major* systems have been listed.

5.3 MOONIE

Catchment: Moonie
Stream: Moonie River
Current Management Category: S4 (NSW and QLD diversion)

	Low Env. Stress	Medium Env. Stress	High Env. Stress
High Extraction			
Medium Extraction		✓	
Low Extraction			

Environmental Stress Indicators:

- For the *fish barriers* indicator, no data were available to suggest the presence of fish barriers. The overall rating for this indicator was determined to be **low**.
- For the *bank condition* indicator, 30% of the representative study area was identified as having a degree of channel alteration or bank erosion. The overall rating for this indicator was determined to be **medium**.
- For the *water quality* indicator, records showed that electrical conductivity and pH were lower than ANZECC Guidelines, while turbidity results were moderately high. The overall rating for this indicator was determined to be **low**.
- For the *gully erosion* indicator, data suggests it is absent in the catchment. The overall rating for this indicator was determined to be **low**.

Primary Stress Factors:

1. Wind erosion.
2. Soil structure decline.

High Conservation Value: Possible High Conservation catchment. Conservation status to be reviewed by River Management Committee.

Identified Conservation Value:

NPWS No NSW Fisheries Yes

Justification

- High species diversity.
- Relatively undisturbed fish populations.
- Relatively low alien fish populations.

Future Risk Considerations:

- NSW approval of lodged surface water licenses
- Construction and activation of already licensed works in Queensland
- Expansion of the current authorised diversions in Queensland – subject to the finalisation of the Water Management Plan. See *Draft Water Management Plan Warrego, Paroo, Bulloo and Nebine Catchments June 2000*
- Floodplain development

SUBCATCHMENT DESCRIPTION	
Area (NSW):	745 km ²
Land Systems Information (NSW):	7 land systems in the catchment
Tenure (NSW):	59% of catchment floodplains and related land systems
No. of Licensed Works¹:	Primarily leasehold under the Western Lands Act, 1901
	QLD: 74 pumps; 44 storages; 4 diversion channels
	NSW: 4 pumps; 2 diversion channels
Licensed Area (Irrigation)	174.5 Ha (within NSW)

¹ Licensed works may be for irrigation, stock and domestic water supply, town water supply, water harvesting and industrial purposes.

Bio-regional Classification:

- **Darling Riverine Plains:** Alluvial fans and plains; summer/winter rainfall in catchments, including occasional cyclonic influences; grey clays, woodlands and open woodlands dominated by *Eucalyptus* Sp.

Major Land Systems (% of catchment and brief description)	
Araluen (Ar)	32% Low red ridges.
Llanillo (Ll)	29% Timbered floodplain of upper Barwon.
Eurie (Ur)	11% Floodplain with well-defined channels adjacent to the Barwon River.
Jomara (Jo)	9% Open Mitchell Grass plains.
Rugby (Ru)	9% Slightly elevated plains of Barwon tributaries east of Narran River.
Upper Darling (Ud)	7% Tributaries of the Culgoa, Birrie, Bokhara, Narran and Bogan.
Mid Darling (My)	3% Darling/Barwon Rivers and the fringing red gum forests.

5.4 NARRAN

Catchment: Narran
Stream: Narran River
Current Management Category: S3 (NSW and QLD diversions)

	Low Env. Stress	Medium Env. Stress	High Env. Stress
High Extraction		✓	
Medium Extraction			
Low Extraction			

Environmental Stress Indicators:

- For the *fish barriers* indicator, a total of nine barriers were identified, all being on the main stem of the Narran River. The overall rating for this indicator was **high**.
- For the *bank condition* indicator, 27% of the representative study area was identified as having a degree of channel alteration or bank erosion. The overall rating for this indicator was **medium**.
- For the *water quality* indicator, records showed that electrical conductivity and pH were lower than ANZECC Guidelines, while total phosphorus, total nitrogen and turbidity results were high. The overall rating for this indicator was **high**.
- For the *gully erosion* indicator, low levels of moderate to severe gully erosion were detected (total <4.5% of catchment area). The overall rating for this indicator was **low**.

Primary Stress Factors:

1. Water extraction.
2. Feral animals.

High Conservation Value: Yes

Identified Conservation Value:

NPWS Yes NSW Fisheries Yes

Justification

- Narran Lakes are listed in the Directory of Important Wetlands.
- Extensive intact riparian vegetation exists in the catchment.

Justification

- High species diversity.
- Relatively undisturbed fish populations.
- Relatively low alien fish populations.

Future Risk Considerations:

- Floodplain and overland flow (off stream) development
- Water diversions
- Instream structures

SUBCATCHMENT DESCRIPTION	
Area (NSW):	14,003 km ²
Land Systems Information (NSW):	21 land systems in the catchment 70% of catchment floodplains and related land systems
Tenure (NSW):	Primarily leasehold under the Western Lands Act, 1901
No. of Licensed Works¹:	QLD: 8 pumps, 5 storages, 3 diversion channels NSW: 18 pumps; 8 storages; 3 diversion channels
Licensed Area (Irrigation)	1,364.5 Ha (within NSW)

¹ Licensed works may be for irrigation, stock and domestic water supply, town water supply, water harvesting and industrial purposes.

Bio-regional Classification:

- **Darling Riverine Plains:** Alluvial fans and plains; summer/winter rainfall in catchments, including occasional cyclonic influence; grey clays; woodlands and open woodlands dominated by *Eucalyptus Sp.*

Flora and Fauna Associations:

- Floodplain associations cover 61.5% of the area and the remainder (38.5%) is defined as 'red land' - land which does not become inundated by floodwaters from the rivers. Of the 61.5% floodplain, 42% is open grassland, 11.5% woodlands, 2.5% lake beds and 5.5% is lignum. These proportions of vegetation associations differ between parts of the same catchment in NSW and Queensland.
- Floodplain woodland is made up of 47.5% coolibah, 9.5% red gum, 12.2% black box, 10.5% woody shrubs and 4.1% Acacias.

Major Land Systems¹ (% of catchment and brief description)	
Llanillo (Ll)	23% Timbered floodplain of upper Barwon.
Lightening Ridge (Lr)	13% Gravelly red ridges with sandy plateaux and drainage lines.
Rugby (Ru)	13% Slightly elevated plains of Barwon tributaries east of Narran River.
Long Meadow (Lm)	7% Open floodplains.
Rostella (Rs)	7% Scalded and floodplain country with minor drainages of the Barwon.
Jomara (Jo)	6% Open Mitchell Grass Plains.
Araluen (Ar)	4% Low red ridges.
Goodooga (Gd)	4% Extensive Mitchell Grass plains.
Gingie (Gi)	4% Extensive plains.
Nidgery (Ni)	4% Floodplains associated with the Bogan, Culgoa and lower Barwon.
Eurie (Ur)	4% Floodplain with well defined channels adjacent to the Barwon River.

¹ Land systems may not total 100 per cent as only *major* systems have been listed.

5.5 PAROO

Catchment: Paroo
Stream: Paroo River
Current Management Category: U3 (NSW and QLD diversions)

	Low Env. Stress	Medium Env. Stress	High Env. Stress
High Extraction			
Medium Extraction			
Low Extraction		✓	

Environmental Stress Indicators:

- For the *fish barriers* indicator, a total of eight barriers were identified on the main stem of the river. The overall rating for this indicator was **high**.
- For the *bank condition* indicator, 10.5% of the representative study area was identified as having a degree of channel alteration or bank erosion. The overall rating for this indicator was **low**.
- For the *water quality* indicator, records showed that electrical conductivity and pH were lower than ANZECC Guidelines, while total phosphorus, total nitrogen and turbidity exceeded ANZECC Guidelines. The overall rating for this indicator was **high**.
- For the *gully erosion* indicator, a small area of the catchment was moderately affected. The overall rating for this indicator was **low**.

Primary Stress Factors:

1. Floodplain landuse.
2. Introduction of exotics.

High Conservation Value: Yes

Identified Conservation Value:

NPWS Yes

NSW Fisheries Yes

Justification

- Paroo Lakes, Yantabulla, Cuttaburra.
- Extensive intact riparian vegetation exists in the catchment.

Justification

- High species diversity.
- Relatively undisturbed fish populations.
- Relatively low alien fish populations.

Future Risk Considerations:

- Water extraction on the Narran River in Queensland – subject to the finalisation of the Water Management Plan. See *Draft Water Management Plan Warrego, Paroo, Bulloo and Nebine Catchments June 2000*

SUBCATCHMENT DESCRIPTION	
Area (NSW):	40,451 km ²
Land Systems Information(NSW):	60 land systems in the catchment 36% of catchment floodplains and related land systems
Tenure (NSW):	Primarily leasehold under the Western Lands Act, 1901
No. of Licensed Works¹:	QLD: 7 pumps; 1 storage. NSW: 4 pumps; 1 storage; 1 diversion channel
Licensed Area (Irrig.):	51 hectares (within NSW)

¹ Licensed works may be for irrigation, stock and domestic water supply, town water supply, water harvesting and industrial purposes.

Bio-regional Classification:

- **Mulga Lands:** (most of the catchment) Undulating plains and low hills on Cainozoic sediments; red earths and lithosols; *Acacia aneura* low woodlands and shrublands.
- **Darling Riverine Plains:** (corridor along the Darling River on the southern edge of the catchment). Alluvial fans and plains; summer/winter rainfall in catchments, including occasional cyclonic influences; grey clays, woodlands and open woodlands dominated by *Eucalyptus* Sp.
- **Broken Hill Complex:** (covers a small area in the southwest corner of the catchment). Hills and colluvial fans on Proterozoic rocks; desert loams and red clays, lithosols and calcareous red earths; supporting chenopod shrublands *Maireana* sp. - *Atriplex* sp. shrublands, and mulga open shrublands *Acacia aneura*.
- Mound springs occur here.

Flora and Fauna Associations:

- Mulga is the dominant shrubland community in this catchment but the plant associations vary with the substrate which can be sandplains and dunefields, hard red ridges and flats, and ranges and hills.
- Channels and basins fringed with Coolibah *Eucalyptus coolabah* and Yapunyah *Eucalyptus ochrophloia* vegetation communities as well as lignum and River Cooba *Acacia stenophylla*.

Major Land Systems¹ (% of catchment and brief description)	
Landsdowne (La)	10% Undulating stony ridges and low tablelands with narrow to broad drainage lines.
Nelyambo (NI)	8% Floodplains of the Darling River.
Waverley (Wv)	7% Extensive undulating sandplain with mulga groves between the Paroo and the Bulloo.
Klondyke (Kd)	7% Dunefields with calcareous swales, swamps and salt lakes along the Paroo.
Avondale (Av)	6% Plains with drainage depressions and sinks.
Reola (Re)	5% Level to slightly undulating sandplains between Paroo and Bulloo.
Glenhope (Gl)	4% Stony plains covered with sand.
Gumballie (Gm)	4% Extensive undulating sandplain with extensive areas of woody weeds.
Warrego (Wg)	4% Warrego River, tributaries, distributaries and floodplains.
Goonery (Gy)	3% Extensive dunefields with sub-terminal pans.
Paroo (Pr)	3% Channels and dunefield islands of the Paroo.
Womparley (Wp)	3% Dissected low stony tablelands with minor breakaways and sandplains.
Copago (Cp)	2% Dunefields.
Duntroon (Du)	2% Sandplain.
Gumparla (Gb)	2% Sandplains with claypans and swamps adjacent to the Paroo.
Janina (Ja)	2% Extensive sandplain.
Pulchra (Pl)	2% Stony plains with low rocky rises.
Paroo Overflow (Po)	2% Extensive active overflow plains.

¹ Land systems may not total 100 per cent as only *major* systems have been listed.

Bio-regional Classification:

- **Mulga Lands:** most of the catchment. Undulating plains and low hills on Cainozoic sediments; red earths and lithosols; *Acacia aneura* low woodlands and shrublands.
- **Darling Riverine Plains:** corridor along the Darling River on the southern edge of the catchment. Alluvial fans and plains; summer/winter rainfall in catchments, including occasional cyclonic influences; grey clays, woodlands and open woodlands dominated by *Eucalyptus* Sp.

Major Land Systems¹ (% of catchment and brief description)	
Landsdowne (La)	18% Undulating stony ridges and low tablelands with narrow to broad drainage.
Nelyambo (NI)	18% Floodplains of the Darling River.
East Toorale (Et)	11% Plains bordering Darling River floodplain.
Ellerslie (El)	7% Sandplains with clumps of brigalow and low dunes.
Ledknapper (Le)	7% Floodplains with extensive areas of low alluvial rises and plains.
Warrego (Wg)	7% Warrego River, tributaries, distributaries and floodplain.
Gumballie (Gb)	6% Extensive undulating sandplain with extensive areas of woody weeds.
Pirillie (Pi)	5% Low rounded ridges of siltified sandstone and conglomerate.
Long Meadow (Lm)	4% Open floodplains.

¹ Land systems may not total 100 per cent as only *major* systems have been listed.



5.7 YANDA

Catchment: Yanda
Stream: Yanda, Mulga and Sandy Creeks
Current Management Category: U4

	Low Env. Stress	Medium Env. Stress	High Env. Stress
High Extraction			
Medium Extraction			
Low Extraction	✓		

Environmental Stress Indicators:

- For the *fish barriers* indicator, a total of seven barriers were identified. Four of the barriers are of minimal significance to fish passage due to Mulga Creeks non-perennial flows. The overall rating for this indicator was **high**.
- For the *bank condition* indicator, 20% of the representative study area was identified as having a degree of channel alteration or bank erosion. The overall rating for this indicator was **low**.
- For the *water quality* indicator, records showed that electrical conductivity and pH were below ANZECC Guidelines, while total phosphorus results exceeded ANZECC Guidelines. The overall rating for this indicator was **low**.
- For the *gully erosion* indicator, 5.5% of the catchment was moderately affected and <2% severely affected. The overall rating for this indicator was **low**.

Primary Stress Factors:

1. Woody weeds.
2. Total grazing pressure by both domestic animals (sheep, cattle) and kangaroos, goats and pigs.

High Conservation Value: Yes

Identified Conservation Value:

NPWS Yes

NSW Fisheries Yes

Justification

- Extensive intact riparian communities.

Justification

- High species diversity.
- Relatively undisturbed fish populations.
- Relatively low alien fish populations.

Future Risk Considerations:

- Soil structure decline
- Weed invasion

SUBCATCHMENT DESCRIPTION	
Area:	42,052 km ²
Land Systems Information:	67 land systems in the catchment 21% of catchment floodplains and related land systems 33% of catchment internal drainage country 9% of catchment colluvial plains
Tenure:	Primarily leasehold under the Western Lands Act, 1901
No. of Licensed Works¹:	9 storages

¹ Licensed works are for stock and domestic water supply purposes.

Bio-regional Classification:

- **Cobar Peneplain:** eastern and northern three-quarters of the catchment. Plains and low hills on Paleozoic rocks; earths, lithosols; Eucalyptus populnea and Eucalyptus intertexta woodlands.
- **Murray-Darling Depression:** south-western quarter of the catchment. An extensive gently undulating sand and clay plain of Tertiary and Quaternary age, frequently overlain by aeolian (wind-formed) dunes. Vegetation consists of semi-arid woodlands of Black Oak/Belah, Bullock Bush/ Rosewood and Acacia sp., mallee shrublands and heathlands and savannah woodlands.

Major Land Systems¹ (% of catchment and brief description)	
Cobar (Cz)	19% Undulating pedeplain with low ridges drainage lines and residual higher peaks.
Ironstone (Ir)	12% Undulating ironstone ridges with narrow to broad drainage flats.
Coronga (Cg)	7% Colluvial plains of the Cobar pedeplain.
Booroondarra (Bz)	6% Bevelled and rounded quartzite and sandstone ranges and hills.
Kenilworth (Kw)	6% Alluvial plains with drainage sinks.
Boulkra (Bk)	5% Extensive low rolling ridges.
Tiltagoona (Tl)	4% Dunefields.
Kopyje (Kp)	3% slightly undulating hard red country with mallee crests.

¹ Land systems may not total 100 per cent as only *major* systems have been listed.

6.0 ADDITIONAL DOCUMENTATION

Supplementary documentation to the Stressed Rivers Assessment Report: Far Western Streams includes the following:

DLWC 1997, *A Stressed Rivers Approach to the Management of Water Use in Unregulated Streams*.

DLWC 1998, *Stressed Rivers Assessment Report: NSW State Summary*.

DLWC (In Draft). *Stressed Rivers Assessment Report: Discussion Paper and Method Report*.

DLWC (In Draft). *Hydrologic Analysis of Unregulated Watercourses for the Stressed Rivers Policy*.

NPWS (In Draft). *High Conservation Value Rivers: A Report on NSW National Parks and Wildlife Service's Preliminary Assessment*.

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8.0 GLOSSARY OF TERMS

Alluvial

Anything that is deposited by stream flow.

ANZECC

Australia and New Zealand Environment Conservation Council.

Aquifer

A layer under ground which holds water or is capable of holding water.

Cap

A limit on the amount of water which may be diverted from the river for consumptive uses.

Catchment

The area of land drained by a river and its tributaries.

DLWC

Department of Land and Water Conservation.

Embargo

A statutory declaration that no further water entitlements will be issued.

Environmental flow

Flows, or characteristics of the flow pattern, which are either protected or created for an environmental purpose.

EPA

Environment Protection Authority.

Estuary

The part of a river in which water levels are affected by sea tides, and where fresh and salt water mix.

Floodplain

A flat land surface beside a stream channel that is flooded when the stream banks overflow.

Geomorphology

The study of the processes which shape the landscape.

Groundwater

Water which occurs naturally under the surface of the ground.

Headwaters

The small streams on the higher ground of a catchment, which flow into a river.

Hydrology

The study of the distribution and movement of water.

Licence

An authorisation issued under the Water Act to take water from a river or stream, to impound water within a river or stream, or to extract water from an aquifer.

Megalitre (ML)

One million litres (roughly the volume of one 50m swimming pool).

Metasediment

Rocks which were originally sedimentary and have since undergone metamorphism.

Non-extractive water use

A use of water, which does not involve the diversion or extraction of water from the water body, such as hydropower generation, recreation, instream or in-situ environment.

Non-point source pollution

Pollution from a broad area or many small sources, such as run-off from farms or urban areas, can include sources which do not come from a single or identifiable pipe or drain.

NPWS

National Parks and Wildlife Service.

Percentile flow

For example, when looking at flow rates, the 80th percentile flow is the daily rate that is exceeded on 80% of the days at a specific location.

Point source pollution

A source of pollution which can be pinpointed, such as a drain from an industrial site or sewage treatment plant, as opposed to pollution from many small sources.

Pool-riffle sequence

Alternately occurring pools (deep part of river with a flat water surface and slow flow) and riffles (shallow area of river in which water flows rapidly over stones or gravel).

Regulated river

A river declared under Section 22C of the Water Act to have flow or supply of water augmented by a major Government rural dam.

Riparian

Adjacent to or associated with the bank of a river or the foreshore of a lake or other water body.

Riparian rights

This right belongs to an occupier of land that forms the bank of a river or lake and enables that person to take and/or store a limited amount of water for non-commercial purposes.

Sediment slug

Pulses of sediment that can migrate downstream during high flow events.

Sinuosity

A measure of the extent to which a stream channel meanders.

Sleeper licence

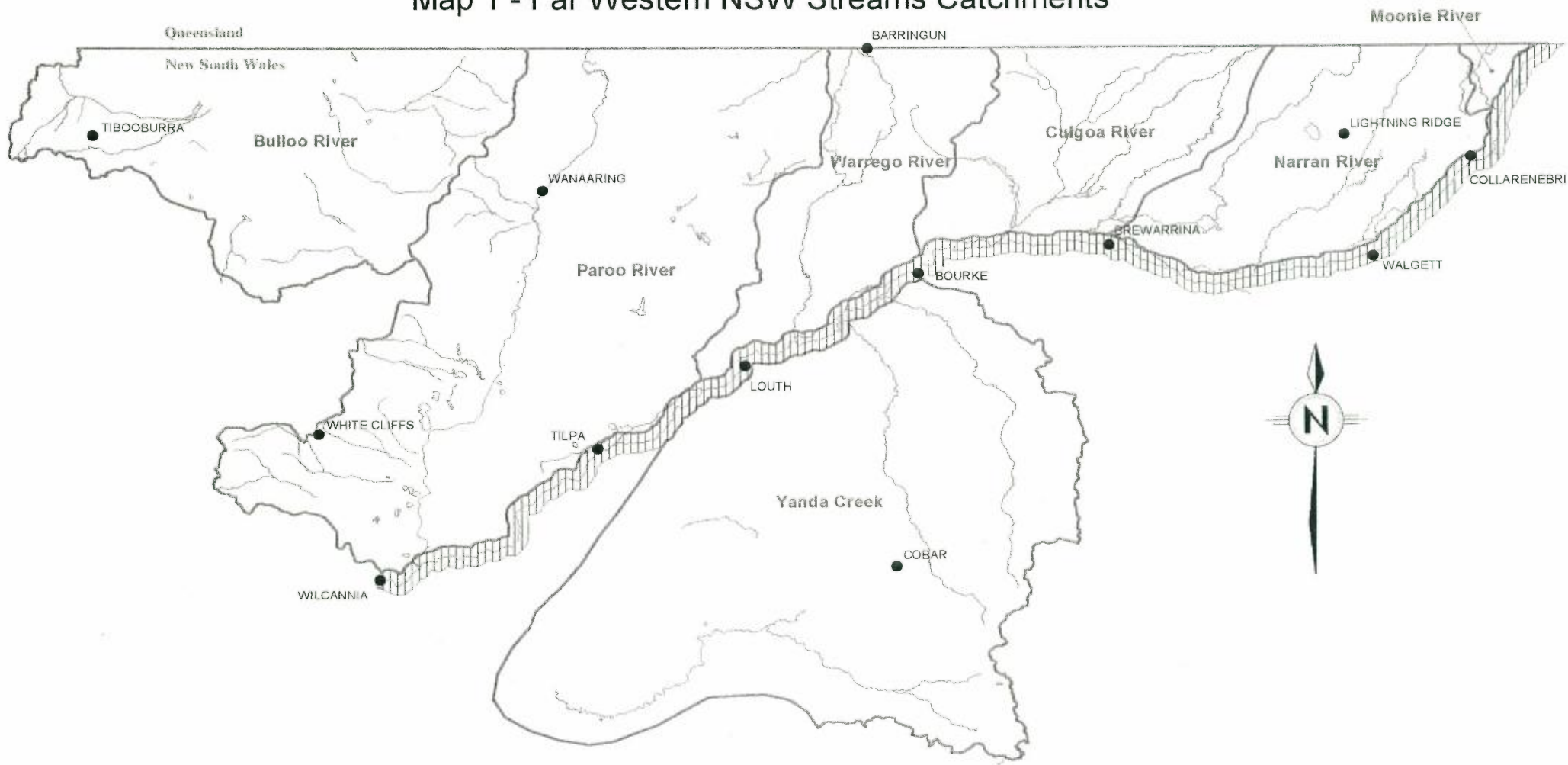
A licence where none of the entitlement has been consistently used, although the licence has been issued.

Unregulated river

A river in which the flow and water supply is not augmented by a major Government dam, but may be controlled by a dams or weirs constructed by urban water suppliers or private users.

APPENDIX 1- MAPS

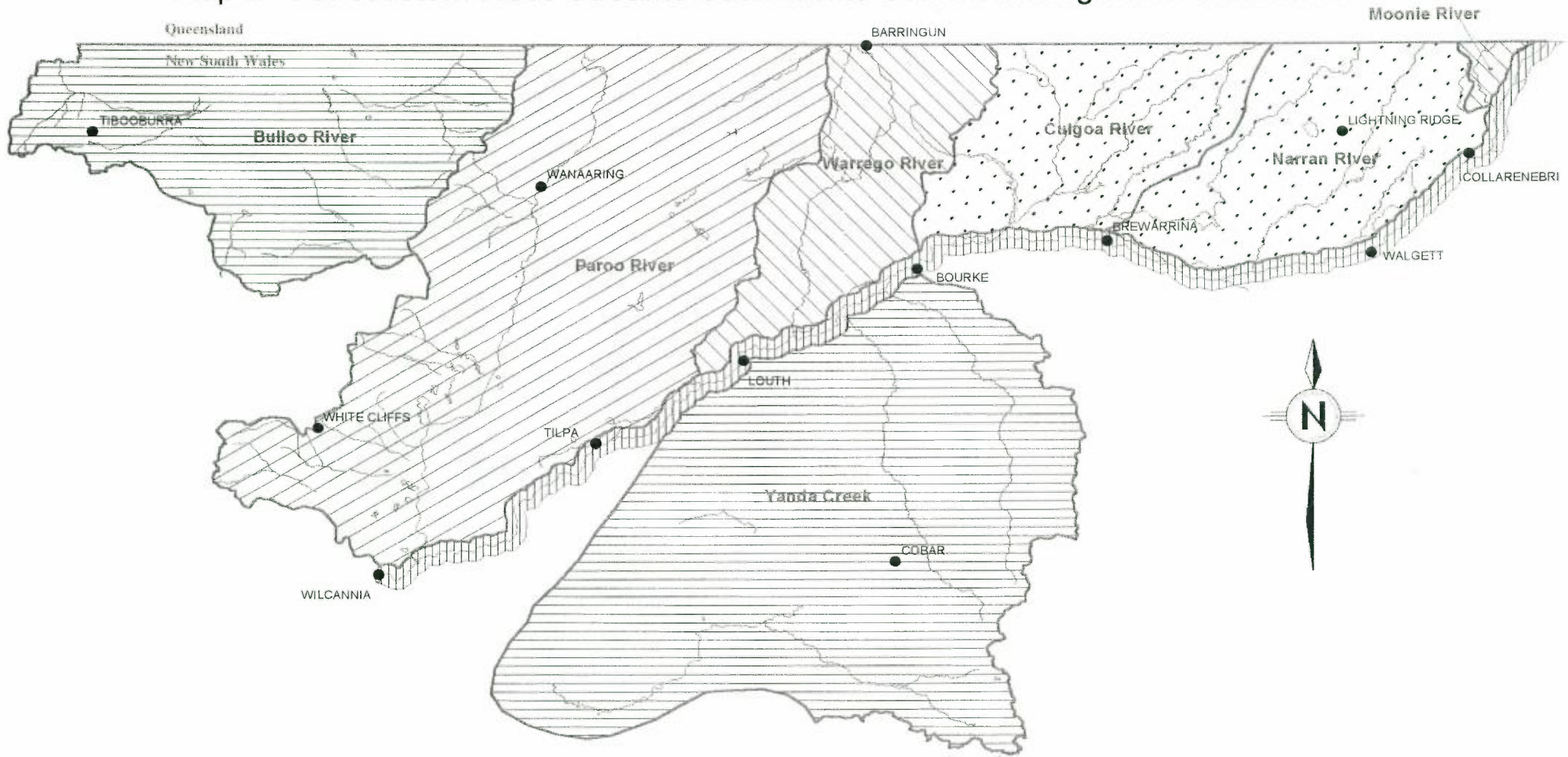
Map 1 - Far Western NSW Streams Catchments



- Legend
- Stream
 - Catchment
 - Barwon-Darling River



Map 2 - Far Western NSW Streams Catchments Current Management Classifications



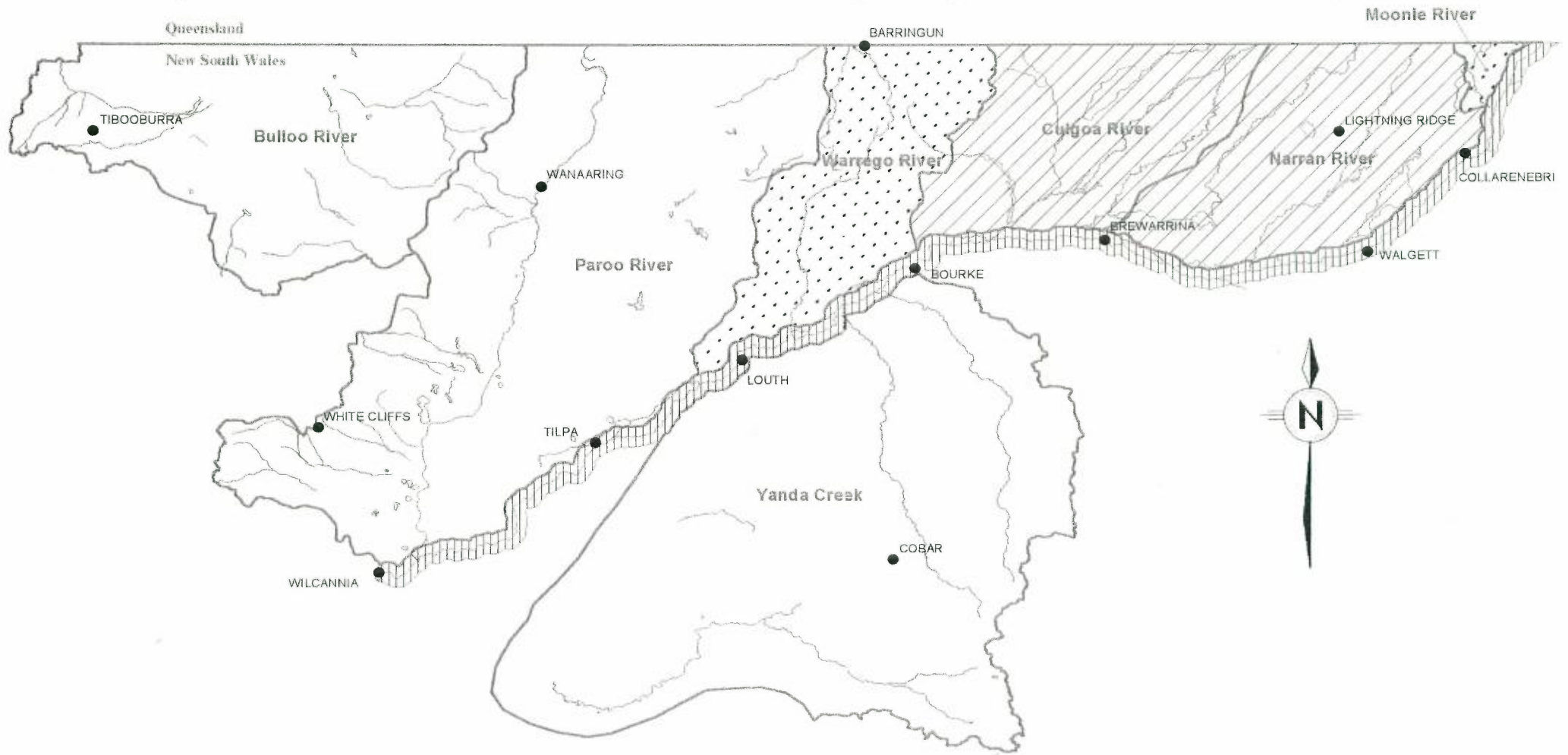
Legend

-  Stream
-  Catchment
-  Barwon-Darling River

	Low Env. Stress	Medium Env. Stress	High Env. Stress
High Extraction	U1	S3	S1
Medium Extraction	U2	S4	S2
Low Extraction	U4	U3	S5

(Note: This includes Queensland diversions)

Map 3 - Far Western NSW Streams Catchments Hydrologic Stress - Current Development

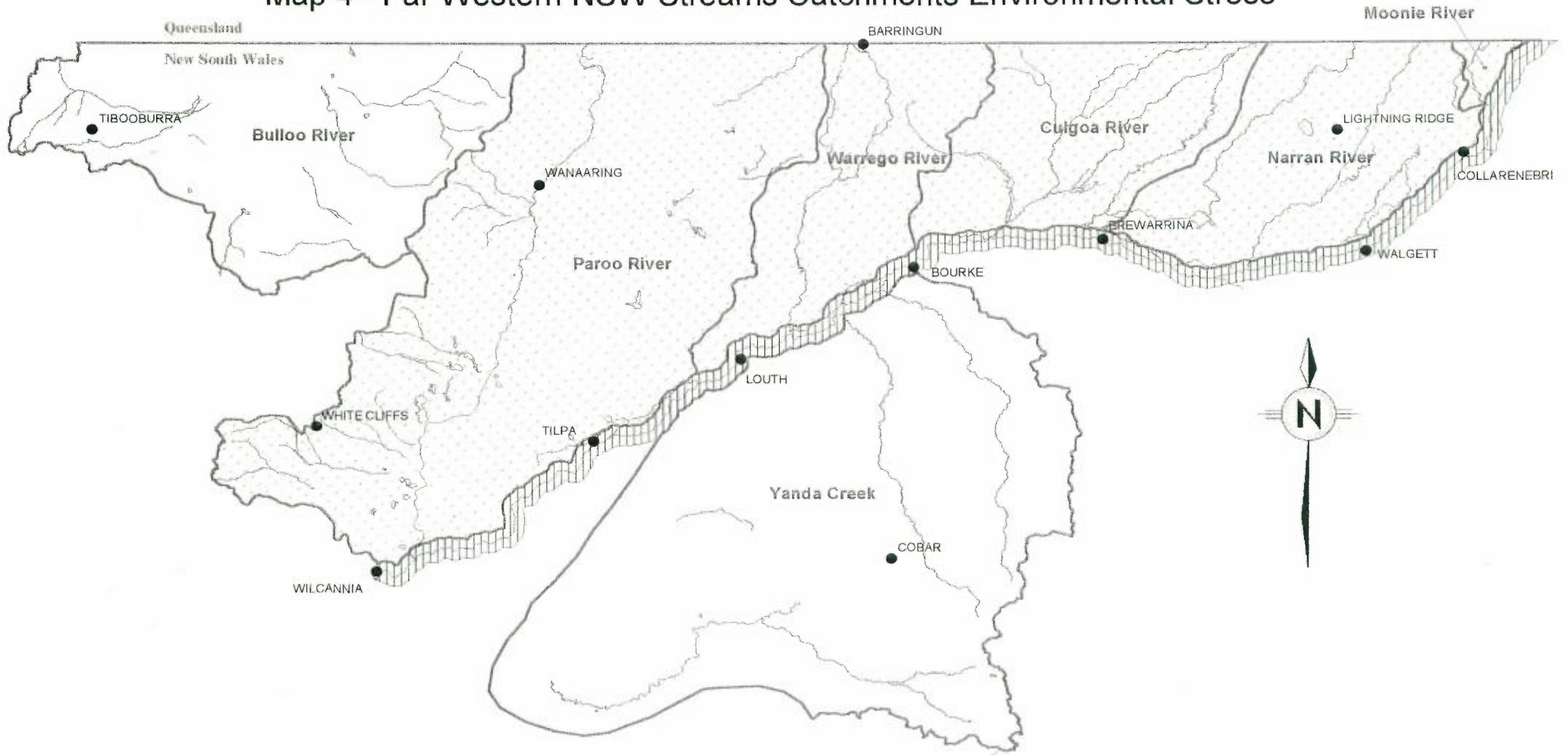


- Legend**
- Stream
 - Catchment
 - ▨ Barwon-Darling River
 - ▧ High
 - Medium
 - Low

(Note: This includes Queensland diversions)



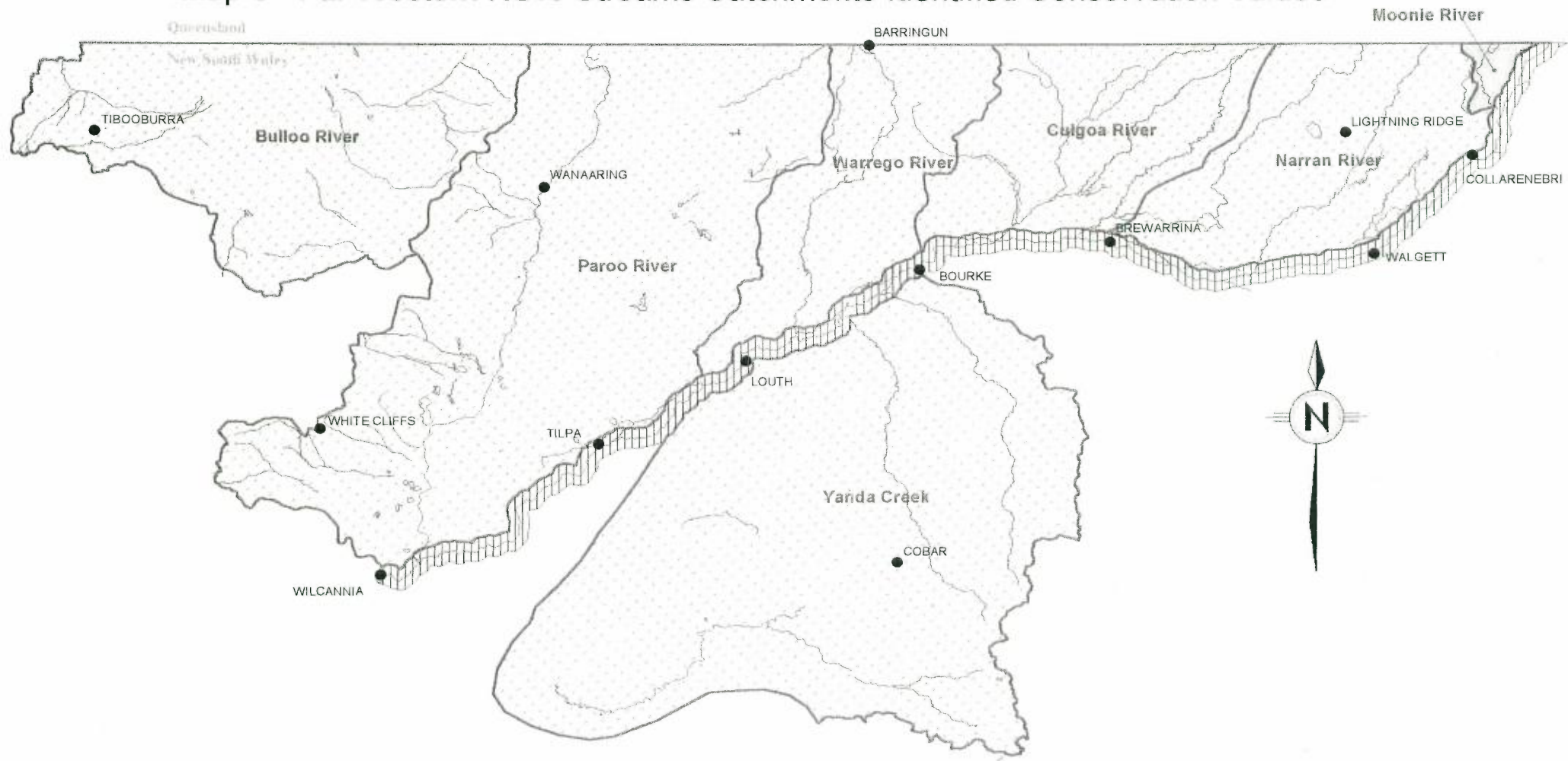
Map 4 - Far Western NSW Streams Catchments Environmental Stress



Legend

-  Stream
-  Catchment
-  Barwon-Darling River
-  Medium
-  Low

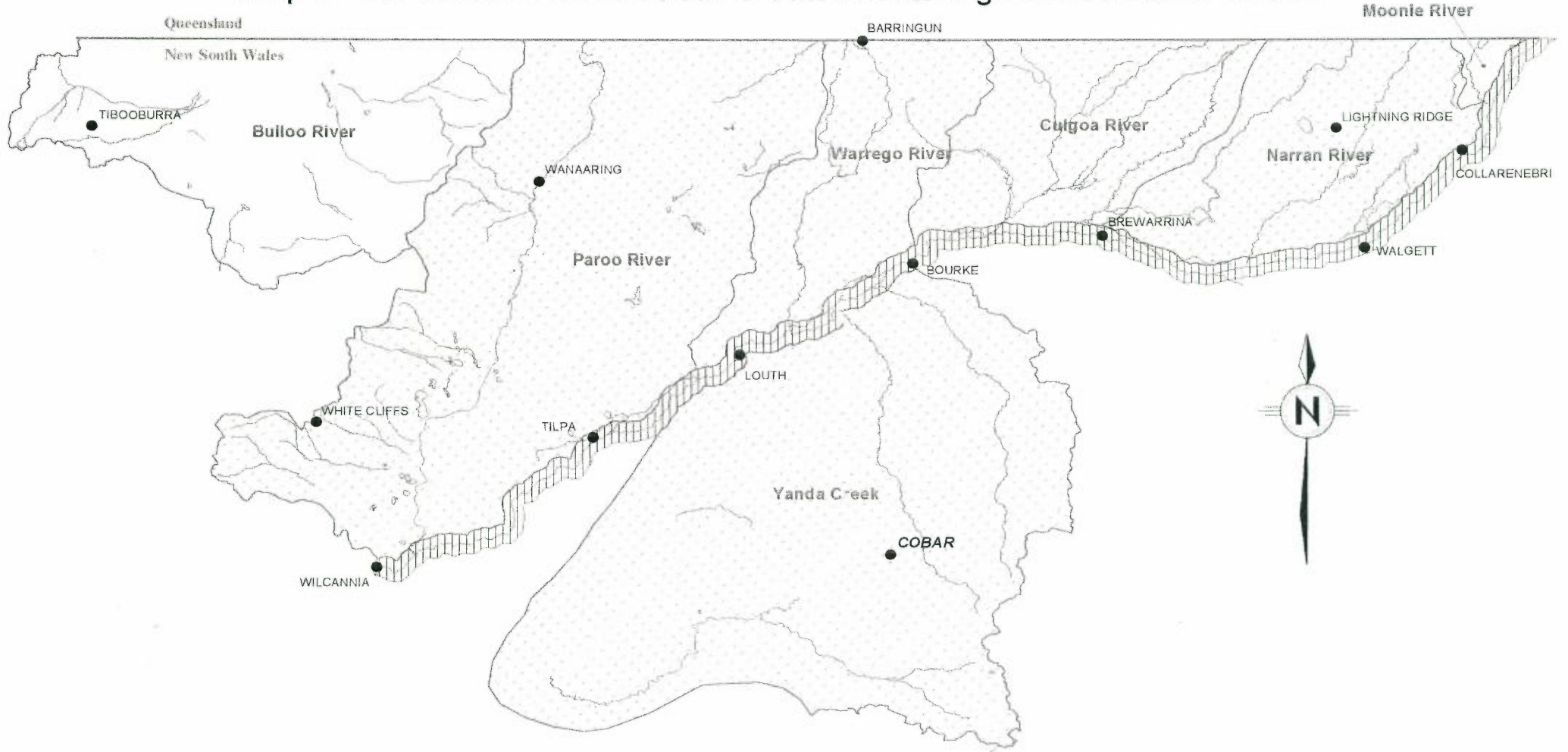
Map 5 - Far Western NSW Streams Catchments Identified Conservation Values



- Legend**
- Stream
 - Catchment
 - Barwon-Darling River
 - As regarded by NSW Fisheries
 - As regarded by NPWS and NSW Fisheries



Map 6 - Far Western NSW Streams Catchments High Conservation Values

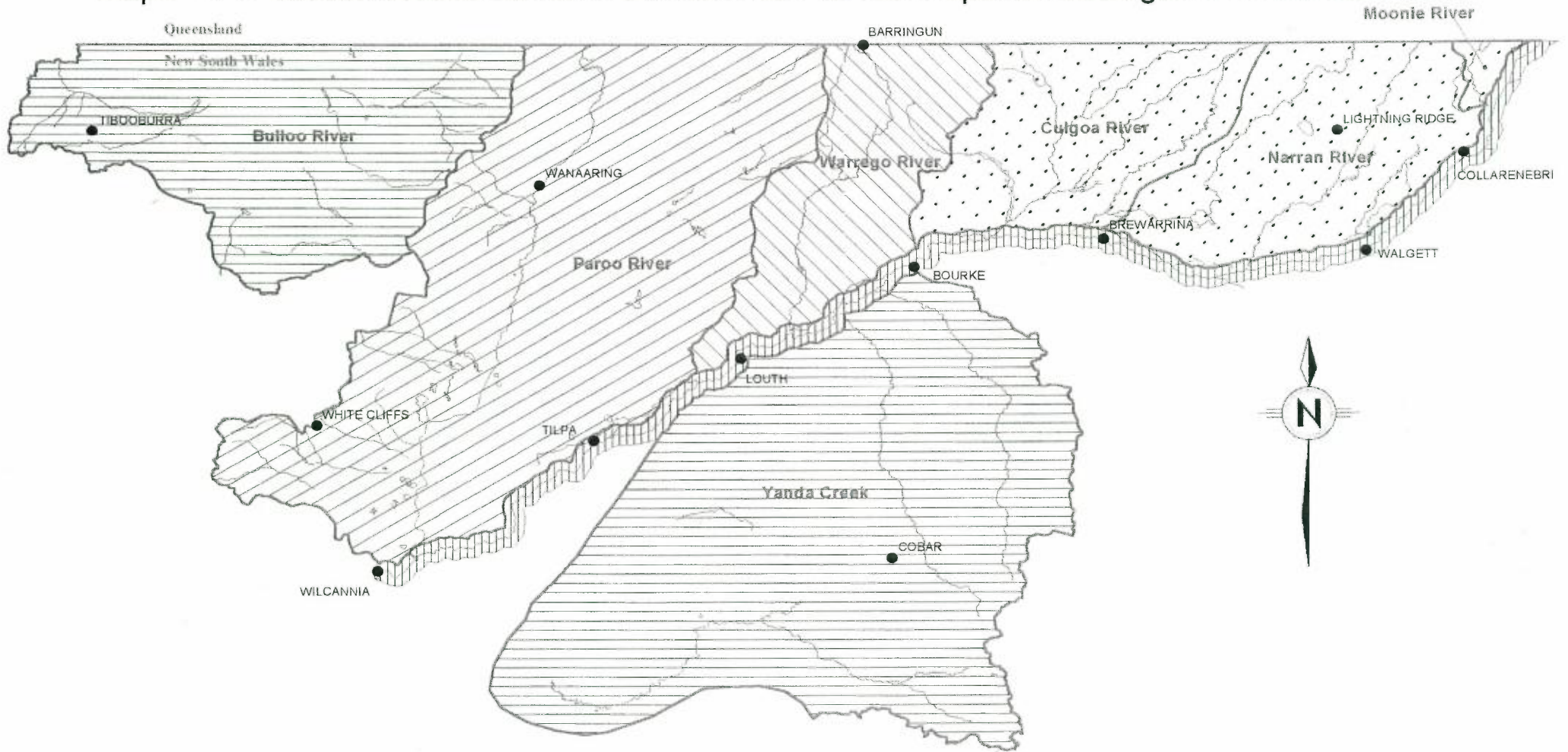


Legend

-  Stream
-  Catchment
-  Barwon-Darling River
-  High Conservation Values



Map 7 - Far Western NSW Streams Catchments Full Development Management Classifications



Legend

-  Stream
-  Catchment
-  Barwon-Darling River

	Low Env. Stress	Medium Env. Stress	High Env. Stress
High Extraction	U1	S3	S1
Medium Extraction	U2	S4	S2
Low Extraction	U4	U3	S5

(Note: This includes Queensland diversions)

