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## 1. INTRODUCTION

This report briefly describes the jarrah forest hydrology work being undertaken and planned for research catchments by the Dwellingup Research Station of the Forests Department of Western Australia. The report firstly describes the Yarragil catchments in the intermediate rainfall zone, lists possible treatments which could be studied, looks at catchment suitability and problems, and timetables when the treatments may be applied. Secondly, the Dandalup catchments in the high rainfall zone are described and discussed in the same way as the Yarragil catchments. Recommendations are then made for further catchments to be instrumented to complement the work being planned for the Yarragil and Dandalup catchments. Studies being undertaken on groundwater are then described.

## 2. Yarragil Catchments (see figure 1)

We have 13 catchments here which have continuous recorders of streamflow, and are therefore suitable for catchment treatments. Catchment treatments which deserve consideration for implementation include:-

- (i) Thinning,
- (ii) Clearfelling and regeneration (effect of forest age),
- (iii) Summer fire resulting in complete loss of all leaves for 1 year (likely to have little effect on streamflow),
- (iv) Banksia removal (likely to have little effect on streamflow) or complete understorey removal,
- (v) Patch clearing (dieback simulation).
- (vi) Pre-emptive FIRS.

for trial mining, but not the 6A side. A weir on 6A would allow us to test a management option on this reasonably small catchment with high quality regrowth jarrah on it.

Definition of Thinning: The term thinning has been used in the above discussion very loosely for a whole range of intensities of logging and thinning, from a light logging, removing maybe only 20% of basal area right through to thinning of 80 or 90% of the basal area.

### 3. Dandalup Catchments (see figure 2)

There are 7 research catchments in this group which are maintained in cooperation with the Public Works Department. Catchment treatments which deserve consideration for implementation include:

- (i) Thinning
- (ii) Rehabilitation of dieback degraded areas
- (iii) Blasting of the impeding caprock layer
- (iv) Bauxite mining

Catchment: Umbucks

Long term average rainfall: 1300mm

Area: 332ha

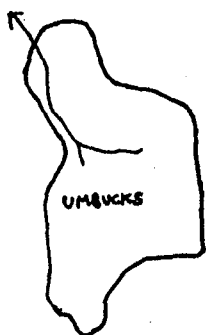
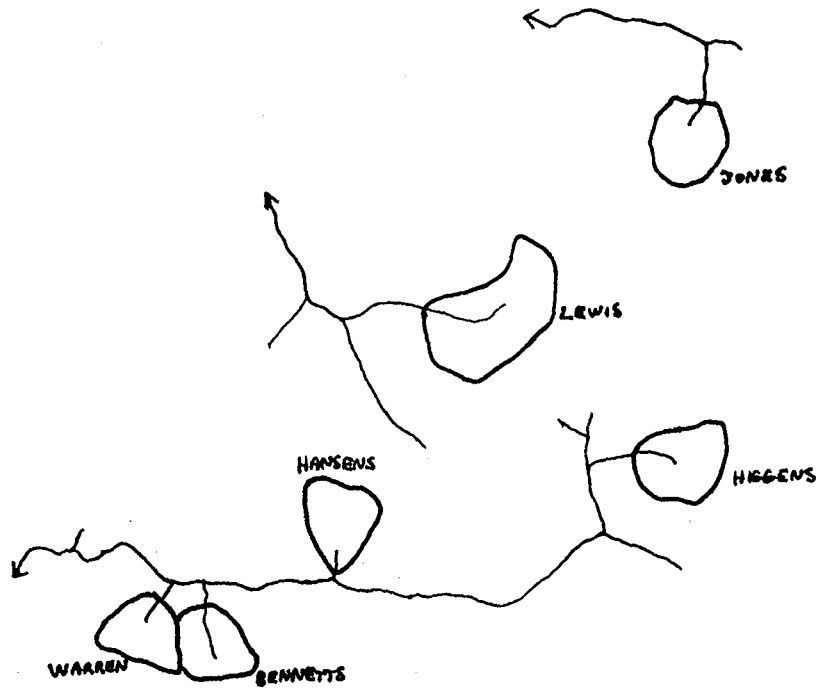
Instrumentation: Stevens A35 type recorder of stage height over a V notch weir since 1978.

Treatments imposed: 40% of catchment cleared for agriculture.

Suitable for: Not suitable for treatment.

Catchment: Warren

Long term average rainfall: 1300mm



DWELLINGUP

Figure 2: Dandalup Catchments

Instrumentation: Stevens A35 type recorder of stage height over a V notch weir since 1977. A number of boreholes since 1984.

Treatments imposed: None

Suitable for: Rehabilitation of dieback degraded areas (60% of catchment), ~~or control catchment.~~

Problems: Unusual in that it flows perennially.

When will treatments be imposed: 1985/

Catchment: Bennetts

Long term average rainfall: 1300mm

Area: 88ha

Instrumentation: Stevens A35 type recorder of stage height over a V notch weir since 1977. A number of boreholes since 1984.

Treatments imposed: None

Suitable for: Caprock blasting and rehabilitation, or just rehabilitation of dieback degraded areas.

*Control for Warren*

Problems: Caprock blasting is not a worthwhile option to test unless it is shown that the caprock is the perching layer. Throssell's work has thrown some doubt on this hypothesis, but it is not conclusive. The work at Dawn Creek should provide more conclusive answers within twelve months.

When will treatments be imposed: 1986?

Catchment: Hansens

Long term average rainfall: 1300mm

Area: 73ha

Instrumentation: Stevens A35 type recorder of stage height over a V notch weir since 1977. Approximately a dozen of each deep and shallow bores since 1984.

Treatments imposed: None

Suitable for: Thinning

Problems: Not the highest quality regrowth forest.

When will treatments be imposed: 1986

Catchment: Lewis

Long term average rainfall: 1300mm

Area: 20ha

Instrumentation: Stevens A35 type recorder of stage height over a V notch weir since 1977.

Treatments imposed: None

Suitable for: Control

Problems:

When will treatments be imposed:

Catchment: Higgins

Long term average rainfall: 1300mm

Area: 60ha

Instrumentation: Stevens A35 type recorder of stage height over a V notch weir since 1977.

Treatments imposed: None

Suitable for: Bauxite mining ? *Thinning maybe ?*

Problems:

When will treatments be imposed: 1992 ?

Catchment: Jones

Long term average rainfall: 1300mm

Area: 69ha

Instrumentation: Stevens A35 type recorder of stage height over a V notch weir since 1977.

About a dozen of each deep and shallow boreholes since 1984.

Treatments imposed: None

Suitable for: Thinning

Problems: *Very low yielding Weir high in landscape. Representativeness*

When will treatments be imposed: 1987 *or 1988 more (likely)*

#### GENERAL COMMENTS

Priority after the Yarragil 4L treatment for catchment treatments has shifted from Yarragil to the Dandalup. There are primarily two reasons for this:

- (i) The Dandalup catchments are within the 25 year mining envelope. Treatments need to be applied as soon as possible so as to get the longest possible post-treatment record before bauxite mining.
- (ii) The potential for increasing <sup>*↑ or decreasing*</sup> streamflow by thinning is far greater in this high rainfall zone.

#### 4. RECOMMENDATIONS FOR MORE RESEARCH CATCHMENTS

It is recommended that two or three new research catchments be instrumented to complement the Dandalup and Yarragil catchments. The proposals are for:

Catchment: Eight Mile Creek (see figure 3)

Long term average rainfall: 1200mm

Area: ~1000ha

Instrumentation: None

Treatments imposed: None

Site-vegetation types: A mixture of high and medium quality regrowth jarrah stands.

## 2. BACKGROUND

### 2.1 Location

Alcoa's proposed 25 year consolidated mining strategy represents a northerly and easterly extension of existing operations at the Huntly minesite. It is located on the Darling Plateau, between the South Dandalup Dam, and the proposed North Dandalup reservoir, both outside and inside proclaimed Disease Risk Areas (Figure 1).

The area is mainly comprised of a mosaic of lateritic uplands (Dwellingup landform) and minor valleys (Yaragil landform). In addition some encised valleys typical of the Murray landform are associated with the little Dandalup Creek, and the North Dandalup River. Three small units of Cooke landform (hills rising above the general plateau), are located on the southern and eastern boundaries of the proposed mining area.

### 2.2 Current Landuse Plans

The current system of landuse priority in the Northern Jarrah Forest was first identified by Havel and Batini (1973), and later adopted by the Government as a Multiple Use Management Policy. Existing landuse priorities are provided in the Department of Conservation and Land Management's General Working Plan No. 87 (1982), Part 2, and are defined in a draft paper titled "Guidelines for Management Principles for Forest Priority Use Areas" (1984).

Priority landuse systems recognize the limits of resources and values and the demands placed upon them. In the Northern Jarrah Forest, priority landuses are allocated which:-

- . best suit the attributes of the natural environment.
- . are dictated by location or accessability.
- . are dependant upon particular public demands.

Areas of the Northern Jarrah Forest may also accommodate a number of other uses, providing they do not impinge upon the management objective of the priority use. For example, bauxite mining is considered a compatible landuse in water production priority areas because yield is enhanced and water quality can be maintained through appropriate mining design.

The proposed 25 year mining area is almost entirely made up of water production and mining, as a dual landuse priority (Figure 2). Here, the management aim is to undertake bauxite mining in a way which ensures that water yields and quality from forested catchments are maintained, and if possible, improved. Other landuses such as jarrah forest silviculture, prescribed burning and recreation are also regarded as compatible uses in this zone.

Within the mining proposal is also located a number of Scientific Study priority areas, in Wilson and Whittaker Blocks. Here, the management aim is to provide the necessary scientific investigation and field demonstration required for effective water production management in forested catchments.

Figure 2, also indicates a small area of catchment protection priority landuse in Scott Block, in the mining proposal. The management aim in this area is to protect water quality values from secondary salinity, through the control of forest cover and access.

Landuse plans currently used in operations are:-

- . prescribed burning plans for the protection of life, property and forest values (Figure 3).
- . hardwood logging, and intensive silviculture plans (Figures 4 and 5). The latter operation aims at jarrah stand improvement in areas of high site quality (Figure 6), with low to moderate potential impact to P. cinnamoni (Jarrah Dieback Disease).
- . recreation plans.

Although separate plans exist, little attempt has been made by the Department of Conservation and Land Management to integrate these landuses on a Regional scale.

### 2.3 Forest Characteristics and Practices

Vegetation of the consolidated bauxite mining area is typical of the Northern Jarrah Forest. Havel (1975, I, II), has identified a strong relationship between landform and site vegetation characteristics of the Darling Plateau.

The subject area comprises two principle vegetation complexes:-

1. Vegetation of the lateritic uplands (Dwellingup and Hester Complex), occurs in high rainfall zones, and is dominated by open forests of E. marginata (jarrah) in association with E. calophylla (marri). Havel (1975, I) describes the principle vegetation types as S (occurring on midslope sites) and T (occurring at sites highest in the landscape, particularly on ridgelines).



A minor component of this landscape unit are small areas of Cooke vegetation complex (Figure \_). Vegetation ranges from open forests of jarrah and marri on deep soils through to heath, herblands and lichens on granite rocks. Dominant vegetation types are R and G (Havel, 1975, I).

2. Vegetation of the minor valleys (Yaragil Complex), occurs in medium to high rainfall zones, but exhibits minimum and maximum swamp developments. Areas of least swamp development are open forests of jarrah and marri, with admixtures of E.patens (blackbutt) and E.megacarpa (bullich) on valley floors. Dominant vegetation types are C, D and W. (Havel, 1975, I, II). Areas where most development occurs is again comprised of open forests of jarrah and marri. Dominant vegetation types are D, E and W (Havel, 1975, I, II).

To a lesser extent, major valleys, combining slopes and floors are representative of the Murray Vegetation complex (Figure \_\_\_\_). The more fertile red and yellow earths of the slopes and high rainfalls, allow the development of high quality jarrah and marri forests, with blackbutt in lower slope regions. Dominant vegetation types are C, Q, U and T (Havel, 1975, I).

Figure 6 shows the distribution of site quality<sup>(1)</sup> within the 25 year proposed mining zone. Although a continuum of site quality exists in the forest, they have been averaged into two classes. Higher site quality areas are generally confined to the Dwellingup and Murray landforms. They are areas of high timber production, where intensive stand improvement (silviculture) may be practiced on sites free from jarrah dieback disease, and where the potential impact of the disease is low, should it be accidentally introduced (Figure \_\_\_\_).

Forest operations within the proposed bauxite mining area are planned within the context of the landuse priority. The main operations undertaken, are concerned with production from, and protection of the forest estate.

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- (i) Site quality is defined as the production capacity of the site, usually in relation to a particular species. High site quality for the subject area is based on height class and percentage crown cover factors. They are stands above 20m predominant height, and greater than 50% crown cover.

The Northern Jarrah Forest has long been regarded as a valued timber resource, and has been subjected to regular cutting since the turn of the century. Early exploitation was replaced in 1920 with silviculturally based tree marking. Here, periodic selective cutting, and the progressive enlargement of groups, has resulted in the distribution of ages and stand structure<sup>(2)</sup> observed today. Figures 7 and 8 shows the decade when cutting last took place in the proposed bauxite mining area, and the size classes resulting from timber production.

The un-even aged nature of cutting observed within the subject area, is typical of selection cut systems within the Northern Jarrah Forest. High quality regrowth (massed) stands, have developed on the more productive sites, and where subsequent regeneration was protected from fire. Pole forests generally comprise groups of original forest, and large groups of second growth forests, resulting from past cutting. Sapling forests consist mainly of an understorey of second growth trees and scrub, with occasional mature trees, as an overstorey.

Figure 4 shows future logging plans and Figure 5 areas for proposed intensive stand improvement, after logging, within the proposed bauxite mining zone.

Protection of the forest estate from destructive agents is fundamental, if its values are to be maintained. Major values recognized within the subject area are water, timber, scientific study, recreation, geological resources, flora, fauna and landscape, and other minor products such as honey and wildflowers.

Management aims to minimize the risks to values, through the control of damaging fires, jarrah dieback disease and other pathogens, feral fauna and exotic weeds.

Figure 3 shows existing fuel ages, resulting from the Department of Conservation and Land Management's prescribed burning programme since the 1950's. Large areas of even-aged fuels have developed since the inception of aerial ignition techniques in 1966. Species composition and diversity, is however, the result of a wider use of fires by aborigines, the intense damaging fires of early European settlement, natural wildfires and recent fuel reduction programmes, using regular and low intensity prescribed burning.

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(2) Defined as massed, pole and sapling forests.

Now that fuels are at a relatively manageable level, the Department of Conservation and Land Management, now prescribes fire to meet landuse priority objectives, as well as protect life, property and the forest ecosystem. For example, in water production areas, surface water run-off can be increased after fuel reduction. Alternatively, prescribed burning near reservoirs may cause a deterioration in the quality of water run-off, and after logging, may inhibit the development of jarrah regeneration.

The distribution of the soil borne pathogen P.cinnamoni (jarrah dieback disease), is shown in Figure 1. Significant areas, low in the landscape, are affected by the disease, both inside and outside Disease Risk Areas.

Disease management in the Northern Jarrah Forest has been aimed at limiting both the introduction, spread and impact of jarrah dieback, and the improvement in forest resistance. Three strategies have been adopted:-

1. the development of accurate maps of disease location. In the subject area, accurate disease distribution, based on 70mm colour photography and interpretation, is limited to parts of Wilson and Scott Blocks. As this information was collated several years ago, changes in disease spread and impact over time, require verification. The remaining 75% of the proposed mining area has been assessed for jarrah dieback disease using pre 1976 black and white photographs. The inadequacy of this technique and the age of interpretation provides a very incomplete picture of the distribution of the disease.
2. the application of "state of the art" forest hygiene procedures. Here the aim is to conduct operations in a way which minimizes the artificial spread of infection to uninfected areas. Techniques such as dry soil operations, split phase work methods and clean-downs, are employed.
3. the management of the forest estate to:-
  - . create conditions unfavourable for survival of the disease eg. Banksia eradication, Acacia promotion, drainage control.

- . minimize the potential for disease introduction. Operations are prescribed, according to plans which predict disease introduction based on current location, topography and local site characteristics.
- . minimize disease impact should it be accidentally introduced. Predicted impact plans are not yet widely in use. Their aim is to interpret likely disease impact, based on the relationship between landform, site and vegetation type.

The intention of ~~ground~~ Dieback Policy '82, was to establish the "ground rules" for disease manage of the forest estate. Its application has received priority within proclaimed Disease Risk Areas, and progressively has been applied to other areas of the Forest Estate, not covered by these regulations.

It is evident that high value areas exist outside DRA. Many of these, due to their remoteness, have been "self-quarantined" and are relatively free from jarrah dieback disease. Urbrae Block is a typical example of this condition, and should be managed according to criteria established in Dieback Policy, 82. Wilson Block which exhibits a high proportion of disease low in the landscape, is also relatively free from disease in upland bauxite resource rich regions of the block. It should also be managed, according to established dieback policies.

## 2.6 Recreation

The Department of CALM's management objective is to provide planned development of recreation activities and facilities, having regard for anticipated social needs and compatibility with the designated priority for landuse. Policies have been specified which require:-

1. the measurement of levels of use for each type of recreation, on each type of land.
2. the investigation of the capacity of the environment to cater for various types of recreation, and methods required to protect the environment from overuse.
3. the provision of facilities and sites for estimated recreation demand, at places which avoid degradation of the environment and in a way which protects the recreation attributes of the locality.

4. continued studies for the progressive development of recreation facilities.
5. liaison with State and Local Government, to integrate recreation development with overall requirements.

Recreation demand within the proposed bauxite mining area is not great, at this stage. No data is available to quantify the level and type of uses experienced.

On a qualitative basis, little, or no recreation has taken place within the proclaimed Disease Risk Area. This has been due to legislative controls on access, and the remoteness of the area. Similarly outside Disease Risk Areas, recreation activities have been low, when compared with other high demand areas eg. Lane Poole Reserve. This has been probably due to a lack of natural landscape features, limited water based opportunities, the existance of bauxite mining operations to the south, and restricted sub-arterial access, particularly in Urbrae Block.

Current recreation demand is likely to increase over the next decade, as the recreation potential of the Northern Jarrah Forest is recognized by the population of Perth. Already, demand within the Lane-Poole Reserve is high, and surplus public are likely to be directed to nearby areas such as the existing Serpentine and South Dandalup Dams, and the proposed North Dandalup reservoir.

Trail access based recreation is currently being demanded by car rally clubs, and increased activity is likely for trail bike riding, 4 wheel driving, bush walking, cycling, sightseeing and horse riding.

In addition, other possible recreation demands are classified as forest based (orienteering, viewing fauna/flora, rock climbing, photography) and facility based (picknicking, barbeques, camping).

## 2.7 Services

The Department of CALM's management objective is to limit the development of public utilities, that result in the loss of forest and conservation values, to those considered essential by Government, and for which there is no reasonable alternative.

The Departments existing policy, is to:-

1. retain the maximum of natural land free from public utilities.

2. guide the location of public utilities on natural lands into areas where landuse conflicts and environmental damage are minimized.
3. rehabilitate redundant sites to suit the designated landuse.
4. liaise with service authorities to ensure their awareness of the effects of service operations (construction and maintenance), on the environment and other landuses.

Major utilities established in the Northern Jarrah Forest are energy, water, townsites, transport (including conveyors) and other utilities, such as Telecom cables, and airstrips.

Within the proposed bauxite mining area, the following services exist:-

Energy: Although no distribution lines have been established, supply lines to bauxite mining infrastructures, and past local inhabitants eg. Huntly, exist.

Water: The majority of the area is covered by either active catchments (lower South Dandalup Pipehead Dam Watershed), or proposed active catchments (North Dandalup Pipehead Dam Watershed). Other significant water resources in the area are the little Dandalup Creek, Mia Creek, The North Dandalup River, and Wilson Brook.

Townsites: The Huntly townsite on North Road operated as a forestry outstation until about 1960. It consisted of a small group of houses and an office, and functioned to service forest management activities in remote areas of the Dwellingup District. This historical and cultural background of early forest workers, must be protected from the effects of bauxite mining.

Transport: Arterial roads throughout the proposed mining area, exist to service public access. Principle routes are North, and Torrens Roads, which provide north-south, and east-west access, respectively. Other roads and conveyors authorized are a necessary component of existing bauxite mining operations. A network of minor roads and tracks is required to provide access to experimental catchment studies at Jones, Higgins, Lewis, Hansen, Warren and Bennett.

The provision of future services is likely to be in the areas of energy and water supply. The plan by the State Energy Commission to provide a large supply of the States energy from the Muja Powerstation at Collie, could result in the location of major distribution lines through or near the proposed mining area. Plans by the Water Authority of Western Australia to develop the North Dandalup catchment by the mid 1990's, have now reached the preliminary ERMP stage.

## DEL PARK/HUNTLY 25 YEAR MINING PLAN

### BACKGROUND

### WATER SUPPLY

### CATCHMENTS

The proposal in this Mining Plan is for mining to occur in the region bounded on the north by Serpentine Main Dam and on the south by the South Dandalup Dam.

Within this area the Water Authority have proclaimed catchments and water reserves on which mining may encroach depending on Alcoa's final requirements. The catchments and water reserves are -

- Serpentine Pipehead Catchment Area
- Serpentine Main Dam
- Dirk Brook Water Reserve
- North Dandalup Dam Catchment Area
- Conjurinup Creek Water Reserve
- South Dandalup Catchment Area
- Lower South Dandalup Catchment Area.

Their actual locations are shown on the attached plan. Lower South Dandalup and Marrinup will not be mined and are not considered further herein.

Table I of these notes provides some of the characteristics of these catchments and the sources on them.

In addition to existing sources the Water Authority has proposals to construct a pipehead source on Conjurinup Creek in approximately 1992 and to upgrade the North Dandalup Pipehead to a storage dam in approximately 1993. System yield variations with these additional sources are 5.5 Mm<sup>3</sup>/Yr and an additional 9.4 Mm<sup>3</sup>/Yr to 21.6 Mm<sup>3</sup>/Yr in the case of North Dandalup for Conjurinup Creek. Again these are demonstrated in the table.

### WATER QUALITY

These catchments are contiguous with State Forest and with minor exceptions (timber production, recreation) they are undisturbed. They also lie within the intermediate to high rainfall zones and therefore produce high quality water. The average TSS levels shown in table 1 demonstrate that the salinity levels are in all cases less than 50% of the longterm criteria set down by the NH & MRC.

Mining has not yet largely impacted on this area however when it does it is expected that a potential risk to water quality, particularly in the form of turbidity, will arise just as has occurred with poor forestry practices in the past. Management practices in other mining areas has demonstrated that this potentiality can be minimised. It will however have to remain as a consideration.

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### YIELD CONSIDERATIONS

The statistics in table 1 demonstrate that these catchments on the whole have relatively low runoff ratios (ie that percentage of average rainfall that is reflected in streamflow). No actions can be permitted in them that will reduce the current yield.

On the other hand any actions that may lead to a sustained increase in yield will extend the period before which addition sources must be constructed. This will have both an economic and social benefit to the State. Economic in that the commitment of capital expenditure can be delayed and social by conserving water resources for possibly other short or longterm uses.

Upto the present the Authority's major concentration in its catchments has been directed at water quality and in particular salinity considerations. As we reach the point of utilising all available surface water sources (and this is not far off) and with our greater meteorological, hydrological and siliculture knowledge the emphasis will change to considerations of yield and its manipulation to get greater benefit from the catchments without sacrificing their stability or timber productivity. This mine plan may well provide the avenues to address these questions.

### VULNERABILITY TO DISTURBANCE TURBIDITY/SALT

The Water Resources within this area or fall into three categories -

- Water Reserves
- Pipeheads
- Storage Dams

The Authority's concern with disturbance in Water Resources is to ensure that disturbance will not have any longterm effects that will put the utilisation of the resource at risk. All the Water Reserves in this area lie within the high rainfall zone and hence disturbance is unlikely to affect salt intrusion into the stream. Soil movement is the most likely disturbance from mining and in relation to Water Reserves this must be considered as a short term event. The amount of disturbance and its timing may influence the Authority's ability to utilise the resource when required. It will not totally prevent the utilisation.

Pipehead Sources are by far the most sensity to the disturbance caused by human activity. Again with the exception of North Dandalup (and a major dam is proposed here in the near future) all the pipehead catchments are in the high rainfall zone and rose little salt risk. Their sensitivity is a direct function of their limited storage. Disturbance in the catchment while it is in operation so much so that heavy rain storms or even regular vehicular traffic during moderate rain events cause sufficient turbidity to require the source to be temporarily closed down. The Authority currently operate on the basis of closing the source down when turbidity reaches 10 to 15 turbidity units and return it to service once the turbidity drops to 5 units. Similarly inputs from other activities (nutrients, bacteriological pollution and the like) within the catchment tend to slow rapidly in the basin of this small storage and place the immediate further use of the source at risk.

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For these reasons the policy on the management of this type of catchment is to be very restrictive on the activities that can be undertaken when the source is on line. Preferentially this would mean complete prohibition of all activity (recreation, forestry, mining etc). Where this is not practical stringent controls are placed on the activity to prevent the possible deleterious effects. These may include the roads to be used; drainage within the operations; times activities may occur and the like.

There are however advantages from the managers point of view in a pipehead when it is not in operation. Because of its almost non existant storage and the fact that only excess winter flows are being utilised the opportunity exists for even quite deleterious activities to occur without threatening the source. It is relatively easy to scour out unwanted polluted water or otherwise remove it and to ensure cleansing of the basin by a first flush in winter prior bringing the source on line. Theoretically it will even be possible to remove short term pollutants which occur in winter by this means but operationally this would be unacceptable.

Large Dams (Serpentine, North Dandalup when it is built and South Dandalup) have significant water basins which in term allow the process of self purification to occur. That is to say the storage time in the lake will allow nature to neutralise all but the most potent of pollutants provided the input is kept to manageable levels. Just what these levels are is unknown but catchments have demonstrated that passive recreation, vehicle traffic and even well managed forestry and mining activities in catchments have little if any affect on the quality of outlet waters where the inflow passes through large storages.

While this buffering is present and does allow some input of disturbance it is essential that this be kept to minimum as we are unaware of the total tolerance levels. The effects of not undertaking this action could be significant to the Authority's ability to supply its consumers. For instance if Serpentine Dam and Pipehead were unavailable to the Authority; this would represent a loss of approximately 30% of available hills capacity. Water which simply could not be made up from other sources.

# EXISTING & PROPOSED SOURCES

SOURCE	Area Km <sup>2</sup>	Type of Dam	Status	Year built	Capacity Kl x 1000	Treatment used	Water Area ha	Wall (m)		Rainfall mm/yr	Streamflow (Mm <sup>3</sup> /yr)	System Yield Ave (Mm <sup>3</sup> /yr)	Annual Runoff ratio %	TSS (mg/l)	
								H	L						
Marringup Brook		Pumpback	Proposed (2005)							1350	12.2	6.8		190	
South Dandalup	311	Dam - Earth	Existing	1974	208200	Chlor.	1960	43	460	1050	33.9	23.76	1090	10	130
Lower South Dandalup	43	Pipehead - Concrete	Existing	1971	48	Chlor.		2	40	1310	12.7				210
"	"	Pumpback	Proposed (2007)							1310	12.7	3.1			210
Conjunctureup	36	Pipehead	Proposed (1992)							1320	10.5	5.5			140
North Dandalup	151	Pipehead	Existing	1970	20	Chlor.	-		5	1270	33.6	11.2	1270	16	190
North Dandalup		Dam	Proposed							1270	33.6	21.6			190
Serpentine	664	Dam - Earth	Existing	1961	184880		1200	52	424	1020	81.3	65.45	1040	11.7	190
Serpentine Pipehead	28	Concrete & Earth	Existing	1957	3860	Chlor.	61	15	146	1020					
Dirk Brook	31	Pumpback	Proposed (1995)							1300	8.9	3.5			150

## RECREATION

### CURRENT SITUATION

Within the areas proposed for this plan there are two principle constraints to recreation; those that relate to water catchment requirements and those that relate to the spread of dieback (ie the quarantine requirements).

These constraints have restricted the legal public recreational pursuits to the more passive endeavours such as pleasure driving; picnicking; sightseeing; bushwalking; hiking; and the like. There has however remained a good deal of ad hoc or illegal activity being undertaken with hunting, marroning and to a lesser degree fishing falling into this category. Other activities that could loosely be related to recreation such as private firewood gathering, seed collection, flower collection and plant collection are also undertaken within this area.

The group activities undertaken in this general area tend to be limited to car rallies who frequent the area at least once a year. Horse and pony club use of the western boundary (along Scarp Road) appears to be of growing interest but as yet hasn't been fully pursued.

Recreation in catchments is governed by the policies of the Water Authority and at present these indicate there is a 2 Km prohibition zone from the Full Supply Level of any reservoir. Additionally horses, trail bikes, off road vehicles and camping is prohibited on catchments. The Authority seeks to avoid any public recreation on pipehead catchments when they are in use.

Dieback quarantine regulations restrict access to large areas of forest for other than fast traffic.

These restrictions illimitate both the prime action of the area (ie water) and large areas of the forest to the recreationist who is most likely to disturb the environment and as such the remainder seems to be of little interest.

The Water Authority is currently consdiering recommendations from the WA Water Resources Council on possible changes to recreational use in catchments. A copy of these recommendations is as follows -

- 1 In their planning and operational activities, water authorities should recognise recreation as an important use for reservoirs and catchment areas. Nevertheless, recreation should be permitted only to the extent that it does not interfere with the primary objective for which the particular reservoir was constructed.
- 2 Each proposal for recreational access or development should be based on a carefully prepared management plan. These plans will need to be flexible and reviewed when necessary to accommodate changing recreational needs and advances in water technology. Recreational activities should be introduced progressively and adjustments made if any undesirable impact is observed on either water quality or the environment.
- 3 No public recreational activities should be permitted on reservoirs or catchment areas unless reliable facilities have been provided and effective supervision is assured.

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Consideration should be given to negotiating agreements with reputable clubs and associations which would permit members to engage in approved recreation activities, provided the organisation undertook responsibility for supervision and the provision of facilities. Similar agreements could be negotiated for "one off" events, which might not strictly comply with these guidelines for general applications.

- 4 For recreational guideline purposes, each catchment should be identified in one of the following classes -

Class I A catchment which serves a small reservoir that supplies domestic water that is diverted direct into a distribution system. Alternatively, the water is discharged into a large reservoir at a point from where its detention for a significant period cannot be assured.

Class II A catchment which serves either a large reservoir supplying domestic water direct to a distribution system, or a small reservoir from which water is discharged into a large reservoir at a point from where its detention for a significant period can be assured.

Class III A catchment which serves a reservoir supply irrigation water.

Class IV A catchment which has been declared as a Water Reserve and is being held for future construction of a reservoir.

- 5 Guidelines for management plans covering recreational access to catchment areas are as follows -

. For catchments in the Class I category, a public exclusion zone should be delineated around the water area of a reservoir and adjacent to inlet streams. Where the catchment is small the exclusion zone would cover all or most of the catchment area.

. For Class II catchments, low intensity recreation such as bush walking and nature study should normally be permitted except for specified exclusion zones such as the shore line close to reservoir outlets. Camping can be considered for special locations.

. For Class III catchments there would normally be no need for restriction on recreational use due to public health aspects. However, activities which cause significant erosion should be excluded.

. With Class IV catchments, the only constraints on recreational use would apply to activities which could cause long term degradation in water quality.

- 6 Guidelines for management plans covering recreational access to reservoir water areas are as follows -

...../

- . On water supply reservoirs where chlorination is the only form of treatment, no water-based recreational activities should be permitted. This restriction covers activities such as wading, swimming, fishing and all forms of boating.
- . On irrigation reservoirs, there need be few constraints on water based recreation other than in respect of the use of power boats.
- 7. Controlled recreation involves additional costs for construction and maintenance of facilities as well as for general supervision. As a general rule, costs which are associated with general use activities near the reservoir, should be met by the managing authority.  
  
However, the cost of those facilities associated with specialised or privileged use, should be met by the users.
- 8. Associated with recreational use and management plans, there should be an ongoing water quality and catchment environment monitoring programme.
- 9. In planning for the recreational use of catchments, the rights of the owners of private land and of companies having authority to work on catchments need to be recognised. This provision also applies to the various government and semi-government agencies having statutory powers covering the use of land.
- 10. Parking areas and (if possible) roadways for public access should be excluded from Class I catchments. On Class II catchments, roadways for public access should be separated from the reservoir water area by a realistic buffer zone and located in a manner that reduces the risk of erosion.
- 11. Sign-posting of catchment areas and reservoirs, particularly public exclusion zones, should be well designed, informative and seek public co-operation in a positive manner.
- 12. Catchment management plans should include a public information program. The objective of the program should be to explain the importance of catchments and reservoirs and why control on access is necessary to protect public health and to retain the confidence of the community in its water supplies.

Should they be implemented there will be a great deal more opportunities for the public and groups to enjoy the forest by the lifting of prohibition zone all be it with specific management requirements. These recommendations do not offer an opening of the flood gates nor do they offer any real change in circumstances to the more destructive type of activities.

Previously in the water background there is a description on the sensitivity of water resource classifications to disturbance. The principles set out in that section will apply equally for recreation as any other disturbance.

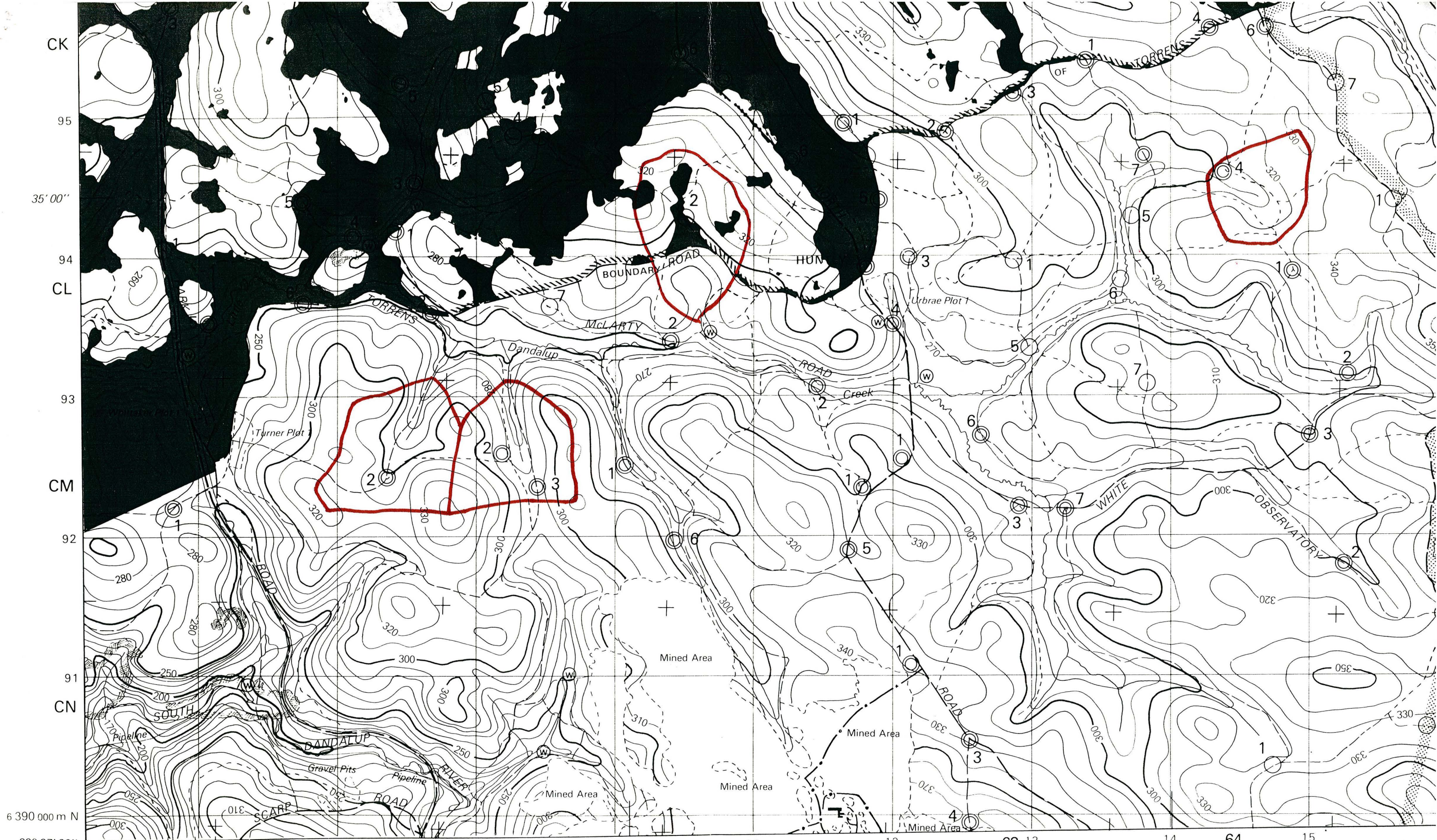
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Mining in this area is unlikely to have a high impact on recreation provided it is constrained in its aerial influence. It is anticipated that the total entry restrictions will apply to mining zones but that these will generally be quite small areas.

There is an opportunity as this plan progresses for appropriately agreed areas to be rehabilitated with some recreational as well as other values in mind however this is likely to be a longer rather than shorter term event in catchments.

3435c





6 390 000 m N  
 32° 37' 30"  
 59 407 000 m E 60 08 09 61 10 11 62 12 13 63 14 05' 00" 64 15

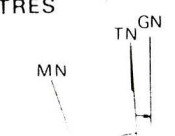
SCALE 1:25000



**MAP LIMITATION**  
 The smallest areas of interpretation on this map are 1 mm in diameter which represents a diameter of 25 metres on the ground. Interpretations shown at this size MAY be less than 25 metres diameter on the ground.

PROJECTION Universal Transverse Mercator C.M. 117°E  
 HORIZONTAL DATUM Australian Geodetic Datum 1966  
 VERTICAL DATUM Australian Height Datum 1971

LEGEND



INDEX TO ADJOINING SHEETS

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