Clearing of 265 Hectares of Native Vegetation: Swan Locations 5433 & 5434 Gingin

Nebru Nominees Pty Ltd

Report and recommendations of the Environmental Protection Authority

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Summary and recommendations

This report provides the advice and recommendations of the Environmental Protection Authority (EPA) to the Minister for the Environment on the environmental factors relevant to the proposal by Nebru Nominees Pty Ltd to clear approximately 265 hectares of native vegetation for the establishment of Tagasaste, a perennial fodder crop species. The area of vegetation proposed for clearing is located on the proponent's farming property, Swan Locations 5434 and 5433, near Mogumber West Road approximately 35 kms north of Gingin. The area is part of a formerly more extensive area of native vegetation recommended for reservation and protection by the EPA through the 1983 System 6 Recommendations.

Section 44 of the *Environmental Protection Act 1986* requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and on the conditions and procedures to which the proposal should be subject, if implemented. In addition, the EPA may make recommendations as it sees fit.

Relevant environmental factors

It is the EPA's opinion that the following are the environmental factors relevant to the proposal:

1. Regional biodiversity conservation (incorporating System 6 areas) - loss of environmentally significant vegetation and adverse effects on conservation of flora and fauna biodiversity in the agricultural landscape;
2. Declared Rare Flora and priority flora - potential effects on populations and habitat of rare restricted or threatened flora species;
3. Groundwater quality, land degradation and related off-site environmental impacts - potential for adverse environmental impacts; and
4. Greenhouse gas emissions - quantity of emissions from clearing of native vegetation.

Conclusion

The EPA has considered the proposal by Nebru Nominees Pty Ltd to clear approximately 265 hectares of native vegetation on Swan Location 5433.

The EPA considers the proposal as proposed is environmentally unacceptable as the proposal:

- cannot be managed to meet the EPA's objectives in relation to regional biodiversity conservation (incorporating System 6 areas); and
- is unlikely to be able to meet the EPA's objectives for Declared Rare Flora and priority flora and Groundwater quality, land degradation and related off-site environmental impacts.

As indicated in the EPA's preliminary Position Statement on the protection of native vegetation, the EPA has been concerned about the environmental consequences of agricultural clearing of native vegetation for some time. While the EPA appreciates that there are matters of equity to be considered in decisions relating to clearing of native vegetation, it holds strongly to the view that from an environmental perspective the challenge now is to establish a response to clearing applications in terms of addressing the equity issues rather than to continue to allow further broadscale agricultural clearing.

Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1) That the Minister considers the report on the relevant environmental factors of ,

    1. Regional biodiversity conservation (incorporating System 6 areas);
    2. Declared Rare Flora and priority flora;
    3. Groundwater quality, land degradation and related off-site environmental impacts; and
    4. Greenhouse gas emissions,

    as set out in Section 3.

2) That the Minister notes that the EPA has concluded that the proposal:

    · cannot meet the EPA's objectives in relation to regional biodiversity conservation (incorporating System 6 areas); and

    · is unlikely to be able to meet the EPA's objectives for Declared Rare Flora and priority flora and Groundwater quality, land degradation and related off-site environmental impacts,

    and should not be implemented.

3) That the Minister notes that the EPA has not included in this Bulletin "conditions and procedures to which the proposal should be subject, if implemented" because the EPA holds the view that the proposal should not be implemented.

4) That the Minister not issue a statement that the proposal may be implemented.

5) That the Minister notes the EPA's other advice presented in Section 4 in relation to clearing of native vegetation for exotic single species crops such as Tagasaste.

Contents

1. Introduction and background

This report provides the advice and recommendations of the Environmental Protection Authority (EPA) to the Minister for the Environment on the environmental factors relevant to the proposal by Nebru Nominees Pty Ltd to clear approximately 265 hectares of native vegetation for the establishment of Tagasaste, a perennial fodder crop species. The proposal is located on the proponent's farming property, Swan Locations 5434 and 5433, near Mogumber West Road approximately 35 kms north of Gingin.

The proposal was referred to the EPA in April 1999 by the Commissioner for Soil and Land Conservation, following consideration by the Level 3 Inter-Agency Working Group (IAWG) under the Memorandum of Understanding for the Protection of Native Vegetation on Private Land in the Agricultural Region of WA (MOU 1997).

The EPA set the level of assessment for the proposal as 'Formal Under Part IV' in May 1999 as a result of:

1. the apparent regional significance of the vegetation communities likely to be present within that proposed to be cleared;
2. advice on the potential impacts of the proposal on the environment provided by Government agencies including the Department of Environmental Protection (DEP), Water and Rivers Commission (WRC) and the Department of Conservation and Land Management (CALM); and
3. the fact that the vegetation proposed for clearing formed part of a formerly more extensive area of native vegetation recommended for reservation and protection by the EPA (referred to as C4: Quins Hill) through the 1983 System 6 Recommendations (EPA, 1983).

Further details of the proposal are presented in Section 2 of this report. Section 3 discusses environmental factors relevant to the proposal. Section 4 provides other advice by the EPA, Section 5 presents the EPA's conclusions and Section 6, the EPA's recommendations.

Appendix 1 lists references cited in the EPA's report. Appendix 2 contains the documentation related to the assessment of the proponent's Notice of Intent by the IAWG. Appendix 3 provides an extract from the EPA's Red Book report on Recommended Conservation Reserves in System 6. Appendix 4 contains details of the calculation of the predicted approximate quantity of greenhouse gas emissions resulting from the clearing proposal.

2. The proposal

The proposal involves the clearing of approximately 265 hectares of native vegetation for the establishment of Tagasaste (*Chamaecytisus palmensis*), a perennial fodder-crop species, on Lot 2, Swan Location 5433, which is part of the landholder's farming property (which also includes Location 5434). A map showing the locality of the proposal is provided as Figure 1. The proposal would reduce the area of native vegetation on the property to less than 10% of the property.

The majority of the vegetation proposed for clearing has regrown from previously authorised chaining and burning by the landholder some 10-20 years ago. However, the clearing operation was not completed and pasture or crops were not established at that time. The vegetation has subsequently grown back to the extent that it is now approaching a condition which is considered comparable with disturbed, but uncleared, native vegetation. The 1999 referral of this proposal to the EPA resulted from a reassessment of the clearing by the Commissioner for Soil and Land Conservation.

At the recommendation of the IAWG, the proposal was referred to the EPA in April 1999 by the Commissioner for Soil and Land Conservation because the proposal was judged to have potential for significant impacts on nature conservation values. The Commissioner indicated at the time of referral that he did not object to the full extent of clearing on land degradation grounds.

The main characteristics of the proposal are summarised in Table 1 below.

Table 1. Summary of key proposal characteristics

Element	Description
Total area of property (Lot 2 Location 5433, Location 5434)	2255 hectares
Area of property currently uncleared	456 hectares (20.2%)
Area to be cleared (area estimated by Agriculture WA)	265 hectares (11.7 %)
Area of native vegetation estimated remaining after proposed clearing	191 hectares (8.5%)
Area of native vegetation proposed to be protected under an Agreement To Reserve (ATR)	0 hectares
Purpose of clearing	Establishment of Tagasaste (*Chamaecytisus palmensis)* as fodder for grazing of stock
Condition of vegetation	'Very good' using condition scale used in Connell (1995)
Mapped description of the Beard vegetation type to be cleared	*Mosaic Shrublands; scrub-heath / Shrublands dryandra heath'* (100%) (from CALM & AGWA GIS data)
Total representation in (IUCN Category I to IV) reserves of Beard vegetation type/s to be cleared	Approximately 60 hectares or 0.3% of Pre-European extent (Hopkins et al, 1996)
Total mapped extent of Beard vegetation type now supporting woody vegetation (any condition)	Approximately 5986 hectares or 31% of Pre-European extent (DEP, CALM, AGWA GIS data)
Mapped description of vegetation complex of area to be cleared according to Mattiske & Havel (1998)	*Mogumber Complex North*
Total Representation in (IUCN Category I to IV) reserves, of vegetation complexes affected	22.5 hectares (<0.1%)
Total mapped extent of affected Vegetation Complex now supporting woody vegetation (any condition, all tenures)	Approximately 8,347 hectares or 36% of Pre-European extent (DEP, CALM, AGWA GIS data)

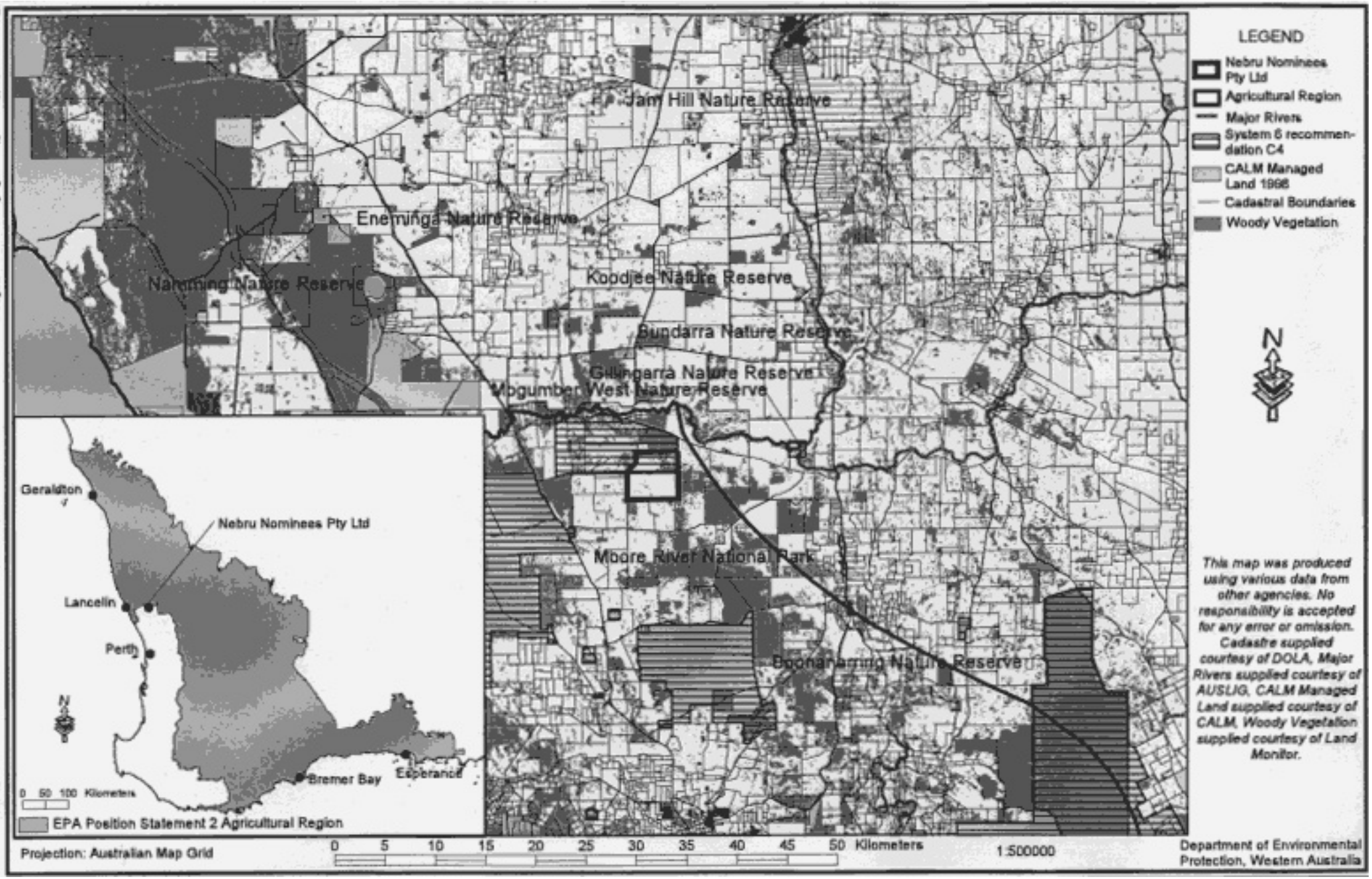

Figure 1. Locality of the proposal.

3. Relevant environmental factors

Section 44 of the *Environmental Protection Act 1986* (the EP Act) requires the EPA to report to the Minister for the Environment on the environmental factors relevant to the proposal and the conditions and procedures, if any, to which the proposal should be subject. In addition, the EPA may make recommendations as it sees fit.

It is the EPA's opinion that the following are the environmental factors relevant to the proposal which require detailed evaluation in this report:

a) Regional biodiversity conservation (incorporating System 6 areas) - loss of environmentally significant vegetation and adverse effects on conservation of flora and fauna biodiversity in the agricultural landscape;

b) Declared Rare Flora and priority flora - potential effects on populations and habitat of rare restricted or threatened flora species;

c) Groundwater quality, land degradation and related off-site environmental impacts - potential for adverse environmental impacts; and

d) Greenhouse gas emissions - quantity of emissions from clearing of native vegetation.

The above relevant factors were identified from the EPA's consideration of the proposal and advice provided by relevant government agencies, in conjunction with the proposal characteristics.

Details on the relevant environmental factors and their assessment is contained in Sections 3.1 - 3.4. The description of each factor shows why it is relevant to the proposal and how it will be affected by the proposal. The assessment of each factor is where the EPA decides whether or not a proposal meets the environmental objective set for that factor.

3.1 Regional biodiversity conservation (incorporating System 6 areas)

Strategic context

It is now well recognised that broad-scale land clearing and consequential salinity have had a dramatic effect on biodiversity in the agricultural area through the direct loss of vegetation communities and plant species, and the associated loss of mammals, birds, and other animals which depend upon large enough areas of healthy bush for food and shelter. These impacts have been reported in both the State and Commonwealth State of the Environment reporting (Western Australian Government, 1998b, and Commonwealth of Australia, 1996).

In response to impacts on biological diversity and nature conservation, as well as land and water degradation, the State and Commonwealth Governments have over recent years developed and implemented various policy positions and programs to provide a strategic context for the protection of remnant vegetation. Relevant aspects of these policies are discussed below.

a) State Government position, 1995

The State Government position of 1995 agreed to apply restrictions on clearing and to augment the Commissioner's assessment of clearing applications to ensure that other natural resource management issues as well as land degradation issues were considered before any further clearing occurred on privately owned land. The position included removing the presumed right to clear in landscapes containing less than 20% of the original vegetation.

The position resulted in the Commissioner imposing restriction of any clearing that would reduce the amount of remnant vegetation or deep rooted perennial vegetation on any property (contiguous landholding) to below 20% of original extent and discouraging clearing in any Shire where the total amount of remnant vegetation is less than 20% of the Shire area.

The Position also put the onus onto the proponent to demonstrate clearly that clearing would not cause land degradation or threaten nature conservation values.

The target criteria of ensuring that there is a minimum of 20% vegetation retention on individual properties and 20% vegetation retention within the Shire, were derived primarily from consideration of land degradation impacts, and did not specifically provide for nature conservation values. In this regard, for Shires with greater than 20% remnant vegetation, the position provided that the Commissioner for Soil and Land Conservation would decide on the need to refer any proposal to the EPA for consideration of nature conservation values in accordance with an agreed Memorandum of Understanding.

b) State Memorandum of Understanding 1997

The State Government position has been implemented via a Memorandum of Understanding (MoU) signed by the Commissioner for Soil and Land Conservation, the Chairman of the EPA, and the Chief Executive Officers of the Department of Environmental Protection (DEP), Department of Conservation and Land Management (CALM), Water and Rivers Commission (WRC), and Agriculture Western Australia (AgWA). The MoU, which integrates the Commissioner's Notice of Intent (NOI) to Clear process with the environmental impact assessment process under the EP Act was signed in March 1997. A summary document containing the main elements of the MoU has been published by Agriculture Western Australia (AgWA, 1997).

c) Other State and Commonwealth strategic initiatives

Since 1995 when the State Government released its position on protection and management of remnant vegetation on private land in the agricultural region, there have been a number of significant policy and program initiatives at both a State and Commonwealth level, which have a bearing on the issue. These include the:

- National Strategy for the Conservation of Australia's Biological Diversity;
- establishment of the National Heritage Trust by the Commonwealth Government;
- Commonwealth and WA State of the Environment reports which identified biodiversity, and clearing and salinity as critical issues; and
- development of the WA Salinity Strategy and formation of a WA State Salinity Council.

d) EPA position

Within the strategic framework provided by the above government policy positions and programs, the EPA has assessed a number of land clearing proposals over recent years.

Based on these assessments, and a workshop with key personnel from agencies which are signatories to the MoU for protection of native vegetation the EPA released a preliminary Position Statement in December 1999, regarding 'Environmental Protection of Native Vegetation in Western Australia' (EPA, 1999). The EPA released the final Position Statement in December 2000 following input from Conservation Groups, government agencies and individual members of the public (EPA, 2000)

Specifically in relation to the agricultural region, the EPA's current position on clearing for agricultural purposes in this region (as stated in Section 4.1 of the Position Statement) includes the following key aspects:

- Significant clearing of native vegetation has already occurred on agricultural land, and this has led to a reduction in biodiversity and increase in land salinisation. Accordingly, from an environmental perspective any further reduction in native vegetation through clearing for agriculture cannot be supported.

- All existing remnant native vegetation should be protected from passive clearing through, for example grazing by stock or clearing by other means such as use of chemicals including fertilisers.

- All existing remnant native vegetation should be actively managed by landholders and managers so as to maintain environmental values.

- Because of the extent of overclearing in the agricultural area, development of revegetation strategies at a landscape level, including provision of stepping stones, linkages and corridors of native vegetation, should be a priority.

- Clearing of deep-rooted native vegetation for replacement with non native deep-rooted perennial crops (eg Tagasaste or blue gums) is generally not regarded as acceptable environmentally and these alternative deep-rooted crops should be planted on already cleared land.

The present proposal is located outside, but in close proximity to, the western boundary of the 'agricultural region' referred to in Figure 1 of the EPA's Position Statement on the protection of native vegetation (EPA, 1999) (see Figure 1). However, many of the considerations relevant to clearing of native vegetation within the agricultural region are also relevant to this proposal. For example, the potential loss of some of the elements of the flora and fauna on Location 5433, which may contain populations of flora and fauna species (such as DRF and priority flora species) which may have become severely depleted within the agricultural region. This matter is discussed further in Section 3.2.

The EPA's Position Statement (Section 4.2) also addresses the basic elements which will be considered by the EPA in assessing proposals. Key elements relevant to the consideration of this proposal, which are referred to in the Position Statement, include the following:

- "No known species of plant or animal is caused to be extinct as a consequence of the development and the risks to threatened species are considered to be acceptable.

- "There would be an expectation that a proposal would demonstrate that the vegetation removal would not compromise any vegetation type by taking it below the "threshold level"of 30% of the pre-clearing extent of the vegetation type."

- "Where a proposal would result in a reduction below the 30% level, the EPA would expect that alternative mechanisms to be put forward to address the protection of biodiversity."

- "There is a comprehensive, adequate and secure representation of scarce or endangered habitats within the project area and/or in areas which are biologically comparable to the project area, protected in secure reserves."

Local context

Proportion of native vegetation remaining on the property

The EPA recognises that the Nebru Nominees clearing proposal is located in the Shire of Gingin where there is approximately 53% of the original vegetation cover remaining, but that less than 20% of the original native vegetation (8.5%) would remain on the property after the proposed clearing.

Plant Communities

Mapping of flora and vegetation at the Plant Community level is not available for the Nebru Nominees property, or for the locality or region. However, DEP advice on analysis of digital vegetation mapping data for the locality of the proposal indicates that Lot 2 contains a vegetation type *(*Beard (1980): *Mosaic Shrublands; scrub-heath / Shrublands dryandra heath*) which is endemic to the immediate locality of the proposal and only occurs within a 50 km radius of Location 5433. Approximately 5986 hectares (or 31% of pre-European extent) of this vegetation type now supports 'woody vegetation' as identified from the Land Monitor (1996) digital dataset. However the condition and ecological viability of the remaining 'woody vegetation' (which has been identiifed from satellite imagery) is unknown. The vegetation type is represented by a total of less than 60 hectares in secure conservation reserves (0.3 % of pre–European extent). There are also a number of populations of DRF and priority flora species occurring within this vegetation type within a few kilometres of Lot 2, further increasing the potential conservation significance of the affected vegetation type.

DEP advice on analysis of mapping data for vegetation complexes in the locality of the proposal based on Heddle et al (1980), which was originally carried out for the System 6 study, has revealed that the proposed clearing is likely to affect vegetation described as occurring within *Mogumber North* vegetation complex. Comparison of vegetation complexes with the Land Monitor (1996) data set for woody vegetation has revealed that approximately 8000 hectares or 36% of pre-European extent of this vegetation complex now supports woody vegetation (any condition, on all land tenures) with approximately 22 hectares (less than 0.1%) of the pre-European extent occurring within secure conservation reserves.

No detailed surveys have been undertaken to date to assess the specific conservation values present on Lot 2. However, botanical consultant Ted Griffin has provided a report on a survey of Lot 1, immediately to the north of Lot 2, that indicates that the vegetation present on Lot 1 "is an important bush remnant that merits protection for its conservation values, especially its representing vegetation that is poorly conserved" (Griffin, 1999). The EPA considers that this advice is also likely to be relevant to Lot 2.

System 6 Recommendation C4

The proposal occurs within a 6278 hectare area containing native vegetation (known as C 4: Quinns Hill) identified and recommended for protection by the EPA in its 1983 'Red Book' report on recommended Conservation Reserves within System 6 (EPA, 1983) (see Figure 2). The Red Book report refers to the area as supporting heath communities which were described as "remarkably rich in plant species" and which were identified as "the closest to Perth of the northern heathlands." This may indicate that the vegetation types present on Location 5433 may support species and represent plant communities occurring at the edge of their natural range. The System 6 Study Report (DCE, 1981) also referred to the C4 area as having "very high conservation value" and as being "important both scientifically and aesthetically". The Study Report also indicated that of the privately owned Locations within the C4 area, Location 5433 was seen as being the highest priority for voluntary acquisition by the Government.

Since the System 6 Study and Red Book reports, the C4 proposed reserve area has been further developed and approximately 70% has now been cleared for various purposes, predominantly agriculture (refer Figure 2). Less than 2000 hectares of C4 now remains vegetated according to DEP interpretation of 1996 satellite imagery. The proposed clearing would result in the area of vegetation remaining in the C4 area being reduced from approximately 30% (1883 hectares) of the original 6278 hectare C4 recommendation area to 26% (1618 hectares). Taking into account the likely variation in condition of the vegetation remaining within the C4 area, the actual area of vegetation contained within parcels which are of sufficient size, shape and condition to remain viable for long term protection of biodiversity, may be significantly less than this figure.

Vegetation quality and viability

The vegetation proposed for clearing is in good to excellent condition and although altered structurally by previous chaining and burning, shows little evidence of impact from introduced

weeds or dieback (see Appendix 2). The area of vegetation remaining on Lot 2 is also considered to be of sufficient size and shape to enable it to remain viable for protection as a reserve in its own right.

The area also has a role in regional biodiversity conservation in the landscape context as it adjoins Lot 1, Location 5433, a large block of intact vegetation adjacent to the north. It also forms part of a significant vegetation corridor between an existing corridor along the Moore River to the north and existing dedicated conservation reserves to the south (see Figure 1).

Assessment

The area considered for assessment of this factor is the portion of Lot 2, Location 5433 affected by the clearing proposal, the C4 System 6 Recommendation area and broader System 6 region.

The EPA's environmental objectives for this factor are to:

1. maintain the abundance, species diversity, geographic distribution and productivity of vegetation communities;
2. ensure that the conservation values of System 6 recommended areas are not compromised;
3. ensure that regionally significant flora and vegetation communities in System 6 are adequately protected; and
4. protect viable examples of native vegetation and fauna habitat, particularly where these contribute to regional biodiversity protection through the provision of buffers, corridors or stepping stones adjoining or linking dedicated conservation reserves.

A key objective of the EPA's 'Red Book' report on recommendations for conservation reserves, was to protect areas which are considered representative of flora and fauna communities within the System 6 region. The vegetation which is the subject of this proposal is clearly important from the perspective of retaining representative areas containing the affected *Beard* Vegetation Type and Vegetation Complexes, which are now very poorly represented in Conservation Reserves. Location 5433 was also specifically identified as a high priority for acquisition within the C4 System 6 area by the Department of Conservation and Environment (DCE)'s System 6 Study Report (DCE, 1981).

The C4 System 6 recommendation area is now significantly depleted (less than 2000 hectares uncleared) and is subject to a number of threatening processes such as dieback, disturbance by feral animals and weed invasion, as a result of fragmentation by clearing and other human activities. Clearing in the area has lead to a significant loss of biodiversity conservation values. Further loss of vegetation within the C4 area will lead to a further significant loss of the biodiversity conservation values present and a further significant reduction of the extent of the plant communities present within the area, which are poorly represented in reserves.

The EPA considers that the vegetation proposed for clearing is a viable example of native plant communities and fauna habitat, which is not well represented in conservation reserves elsewhere within the region. Due to its position, this vegetation would also contribute to regional biodiversity protection if retained and protected as part of a reserve incorporating Lot 1 of Location 5433, rather than being cleared.

Summary

Having particular regard to :

a) the high level of significance of the vegetation types affected by this proposal in that these types are known to be limited in areal extent to a level which is very close to the 30% threshold referred to in the EPA's Position Statement for the Protection of Native Vegetation. The vegetation types are also known to be poorly represented in conservation reserves, support high levels of plant diversity and potentially contain populations of species (including rare species) and plant communities at an extremity of their natural range or impacted by clearing elsewhere;

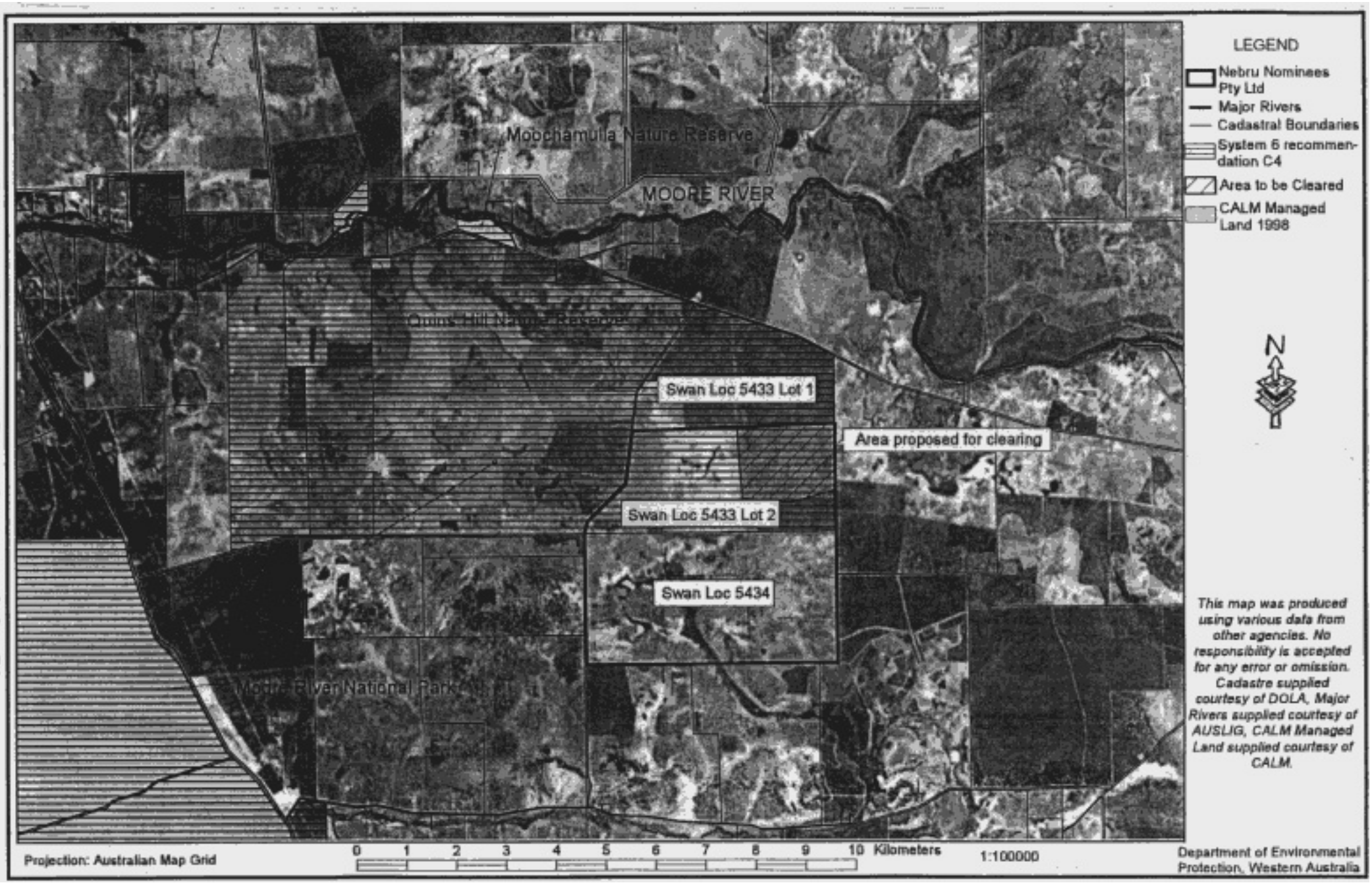

Figure 2. Locality of the proposal in relation to System 6 recommendation C4.

b) the advice and recommendations of the Department of Conservation and Environment of 1981 in the System 6 Study Report, and the EPA in the 1983 Red Book Report, with respect to C4 System 6 Reserve recommendation area;

c) the degree of clearing and other losses of and threats to environmentally significant vegetation which has already occurred in the C4 System 6 recommendation area;

d) the viability of the area of the vegetation proposed for clearing as an area capable of contributing significantly to the protection of the biodiversity values of the C4 System 6 recommendation area;

e) the proximity of this area to Lot 1, Location 5433 (a large block of intact native vegetation adjacent to the north); and

f) the position of the proposal area as a linking component of a semi continuous corridor between other significant areas of native vegetation within the predominantly cleared landscape of this part of the System 6 region,

it is the EPA's opinion that the proposed clearing should not be permitted as it would not meet the EPA's objective for regional biodiversity conservation.

3.2 Declared Rare Flora and priority flora

Description

No flora or vegetation surveys have been undertaken to establish the presence, absence or extent of any populations of Declared Rare Flora or priority flora within the vegetation proposed for clearing.

However as mentioned in Section 3.1, CALM has identified that the locality (15 km radius) of Location 5433 contains a number of populations of DRF and priority flora species occurring on the *'Mosaic Shrublands; scrub-heath / Shrublands dryandra heath'* vegetation type.

There is also a known population of the DRF species *Dryandra mimica* located in very close proximity (less than 1km) to Location 5433, occurring on a soil type which also appears to occur within the northern part of Lot 2 which is proposed for clearing (Griffin, 1999).

Dryandra mimica is known from 6 populations, in 3 disjunct localities from the Whicher Escarpment east of Busselton to the Mogumber area (near the proposal site). Three of the populations occur within degraded native vegetation on private property in the Perth Metropolitan area (Kelly et al, 1999).

The species is listed by the World Conservation Union (IUCN), Environment Australia and CALM as being of 'Endangered' [1]conservation status (K Atkins CALM Wildlife Branch, pers comm). Therefore the populations of *Dryandra mimica* in the Quins Hill area may be regarded as significant in retaining populations and intact habitat for the northern extent of the species, which is regarded as being genetically quite distinct from the southern (Whicher Escarpment) populations, potentially warranting consideration as a separate taxon (Kelly et al 1999).

Assessment

The area considered for assessment of this factor is the portion of Location 5433 area affected by clearing (this includes Lot 1, Location 5433).

The EPA's environmental objective for this factor is to protect Declared Rare Flora (DRF) and priority flora, consistent with the provisions of the *Wildlife Conservation Act 1950.*

[1] This relates to the IUCN (Red List) categories for the conservation status of threatened flora species (IUCN, 1994). There are 3 levels in this classification. An 'Endangered' taxon is one which "is not Critically Endangered but which is facing a very high risk of extinction in the wild in the near future as defined by any of the (IUCN) Criteria".

The EPA is unable, based on the information currently available, to determine whether any populations of DRF or priority flora currently exist on Lot 2 Location 5433 or will be affected by the proposal. However, given the proximity of one population of *Dryandra mimica* and the fact that other populations of DRF or priority flora occur locally, on areas mapped as being of similar vegetation type, it would appear likely that the area to be cleared under this proposal would impact on populations of, or suitable habitat for Declared Rare or priority flora.

The EPA is therefore unable, based on currently available information, to determine whether the EPA's objectives can be met for this factor. However, it is considered that, given the proximity of the nearby *Dryandra mimica* population, the likelihood of the presence of DRF on the property and the likely effects of clearing on any DRF, or DRF habitat present, the proposal is unlikely to be able to meet the EPA's objectives for this factor.

Summary

Having particular regard to:

a) the fact that a flora survey of the area proposed for clearing to identify populations of DRF or priority flora has not been carried out at this time;

b) the known presence of a number of populations of DRF and priority flora in close proximity to, or within the locality of, the proposal, within areas mapped as being of similar vegetation type, and

c) the likelihood that the subject land which is proposed for clearing, would provide suitable habitat for DRF and priority flora species known to occur locally;

the EPA considers that the proposal is unlikely to be able to meet the EPA's objective for this factor.

3.3 Groundwater quality, land degradation and related off-site environmental impacts

Strategic context

Land degradation caused by erosion, salinisation, waterlogging and acidification were key issues identified for action by the Government in Western Australia's State of the Environment Report (Western Australian Government, 1998b) and the Salinity Strategy (Western Australian Government, 2000a). Native vegetation management has been identified in the Salinity Strategy as an important tool to assist in the management of these threats.

Additionally the EPA has expressed the view in its preliminary Position Statement on the protection of native vegetation (EPA, 1999) that:

"Clearing and consequential salinity are having a devastating effect on biodiversity through the direct loss of plant species, and the associated loss of mammals, birds and other animals which depend upon large enough areas of healthy bush for food and shelter. Many of the remaining areas of native vegetation in the wheatbelt are small islands surrounded by farmed land, and the fauna are unable to move to other areas when they are too far apart and not linked by 'stepping stones' or corridors."

The present proposal is located outside but in close proximity to the western boundary of the 'agricultural region' referred to in Figure 1 of the EPA's Position Statement on the protection of native vegetation (EPA, 1999) (see Figure 1). However, many of the considerations relevant to clearing in the agricultural region are also relevant to this proposal. The catchment within which the proposal occurs has predominantly been cleared for agriculture and lands salinisation and the related environmental impacts are therefore relevant.

Local context

Depending on the extent and location of the activity, clearing of native vegetation has potential to have impacts on hydrological systems such as groundwater levels with flow-on consequences on ecosystem function, biodiversity and/ or land productive potential.

The potential for impacts from the present proposal on groundwater hydrology, (and consequently on surface water quality and land and ecosystem degradation) will depend upon a number of factors, in particular:

- the reduction in water use (evapotranspiration) caused by clearing of native vegetation in both the short term and longer term; and
- the ability for the proposed Tagasaste fodder plantation to achieve similar levels of water use (through evapotranspiration) to native vegetation.

The Commissioner for Soil and Land Conservation and the WRC considered the potential for the present proposal to have impacts on water quality and land degradation as part of the MoU assessment of the proposal by the IAWG.

A copy of the advice of the Commissioner and the WRC to the MoU Level 3 IAWG are provided in Appendix 2.

The WRC has advised that the proposal is likely to impact on groundwater quality and level as a result of increased groundwater recharge and lead to an increase in the down-slope areas affected by salinisation. The EPA notes that the Moore River National Park lies down-slope of the proposal.

The Commissioner for Soil and Land Conservation has accepted the WRC advice and agrees with the view that the decrease in evaporative discharge resulting from the clearing and subsequent change of land use is likely to affect the catchment hydrology. The Commissioner has also advised that the proposal would be expected to lead to a future increase in salinity down-slope of the areas cleared. This is partly as a result of the region within which the property is located being underlain by a band of highly saline marine deposits known as the Osborne Formation. The Commissioner has also identified some potential for land degradation caused by wind erosion as a result of the light sandy soils which are present (see Appendix 2).

The WRC has also advised that the landholder has not demonstrated that heavily grazed Tagasaste would be as effective as native vegetation, in controlling groundwater recharge. Furthermore, the Commissioner has advised that if clearing were to be approved under the Soil and Land Conservation Act and the property changed hands at some time in the future, then the incoming landholder would be able to convert the area planted to Tagasaste, to another crop which used less water, without having to seek further approval (unless a Soil Conservation Notice was placed on the property).

The EPA acknowledges, that should the proposal be allowed to proceed by the Minister for the Environment, under the EP Act as a result of this assessment, the proponent could be required, (through a recommended Environmental Condition) to manage levels of animal stocking and foliation of Tagasaste in order to maintain a level of evapotranspiration which could reduce the potential for hydrological impacts. However, the EPA considers that as the Tagasaste crop would be established expressly for the purpose of grazing by stock, such a condition may be difficult for the landholder to comply with, while maintaining a viable grazing enterprise. Additionally as Tagasaste is effectively a monoculture (single species crop) it may become vulnerable in time to attack by plant diseases or insects, reducing its ability to use as much rainfall and prevent as much groundwater recharge as the native vegetation.

Assessment

The area considered for assessment of this factor is the locality of Location 5433 and downstream water resources and riparian ecosystems.

The EPA's environmental objective for this factor is to maintain or improve the quality of groundwater to ensure that existing and potential uses, including ecosystem maintenance, are

protected, consistent with the draft WA Guidelines for Fresh and Marine Waters (EPA, 1993) and the ARMCANZ National Water Quality Management Strategy.

The EPA notes the advice of the WRC and the Commissioner for Soil and Land Conservation on the potential effects on groundwater (and resulting surface water) quality from the proposal and the potential flow-on effects of the proposal on land degradation and biodiversity values in downstream areas such as the Moore River National Park.

Based on this advice and the uncertainty with regard to management of the proposed Tagasaste crop so as to maintain an equivalent level of evapotranspiration to that of the existing native vegetation, the EPA considers that it is unlikely that the proposal could be managed so as to meet the EPA's objective for this factor.

Summary

Having particular regard to the:

a) advice of the WRC that that this proposal will affect groundwater quality and level as a result of increased groundwater recharge and lead to an increase in the down-slope areas affected by salinisation;

b) level of uncertainty expressed by relevant agencies that a Tagasaste plantation could and would be managed to maintain an equivalent level of water use to the existing native vegetation; and

c) the significant environmental values potentially affected by further changes to groundwater levels and water quality;

it is the EPA's opinion that the proposal is unlikely to be capable of being managed so as to maintain an equivalent level of evapotranspiration to the existing native vegetation, and is therefore unlikely to be able to meet the EPA's objective for this factor.

3.4 Greenhouse gas emissions

Description

The clearing and burning of approximately 265 hectares of native vegetation will lead to the emission of greenhouse gases including carbon dioxide.

The prediction of the precise amount of greenhouse gas emissions attributable to a specific proposal for a land use change from native vegetation to agriculture is complex. It involves the estimation of emissions from the above-ground biomass to be removed, decay of surface and subterranean material such as tree roots, emissions from the soil profile, the long term carbon sink effect of vegetation retention and carbon fluxes generated by agricultural activities such as grazing.

Detailed estimation of the long-term carbon sink effect of not clearing the vegetation (ie carbon sequestration by the vegetation over the long term, if it were retained) and carbon fluxes generated by agricultural activities, including grazing of Tagasaste, is beyond the scope of this assessment.

However, the Commonwealth body, the National Greenhouse Gas Inventory Committee (NGGIC) has developed a simplified methodology for calculating greenhouse gas emissions from clearing in order to assist land managers and decision-makers in broadly assessing the effects of land management and development. These are discussed in the booklet "Land Use Change and Forestry: Workbook for Carbon Dioxide from the Biosphere" (Commonwealth of Australia, 1997).

By adapting the methodology outlined in the NGGIC workbook, and making the assumption that essentially all of the above ground biomass from clearing will be burnt or otherwise converted into greenhouse gases within a ten year period following clearing, the DEP has estimated that approximately 3816 tonnes of carbon would be emitted from the initial clearing of the native vegetation on Lot 2, Location 5433 over a ten year period. A further estimated loss of

5194 tonnes of carbon from the soil over a 20 year period, has also been predicted. An approximation of the total potential carbon emissions from clearing (which excludes the effect of change in land use) was therefore given as 9000 tonnes.

Assessment

The EPA is aware of the commitment that Australia has made under the Kyoto protocol to ensuring that Australia's greenhouse gas emissions do not increase by more than 8% over 1990 levels for the first reporting period from 2008 to 2012. The EPA is also aware that Australia will be reporting in 2005 on progress toward meeting the target. The National Greenhouse Strategy also encourages the retention of native vegetation as a carbon sink.

While the EPA does not have a specific objective for the assessment of land clearing proposals in terms of levels of greenhouse gas emissions which are acceptable, the clearing of vegetation under the present proposal will not assist in meeting Australia's greenhouse emission targets. The EPA has also taken the impact of land clearing on greenhouse gas emissions into account, in formulating its position statement on the protection of native vegetation.

4. Other advice

The EPA has been concerned for some time about the potential for native vegetation to be replaced by Tagasaste fodder crops, from the perspective of parity of effect on groundwater hydrology (water use and recharge) and conservation of biodiversity.

The EPA considers that it is yet to be demonstrated that Tagasaste is an effective substitute for native vegetation in terms of preventing groundwater recharge (and the resultant flow-on environmental impacts) on either an annual or long term basis.

Furthermore, the EPA considers that replacement of native vegetation with Tagasaste fodder crops and other single species deep-rooted perennial crop species (such as timber plantations or orchards), is likely to impact significantly in cumulative terms, on biodiversity conservation and landscape ecological function.

The EPA therefore advises that it continues to be of the view that replacement of native vegetation with Tagasaste or other exotic or single species crops is generally considered environmentally unacceptable.

The EPA supports the establishment of plantations or native vegetation on cleared agricultural land.

5. Conclusions

The EPA has considered the proposal by Nebru Nominees Pty Ltd to clear approximately 265 hectares of native vegetation on Swan Location 5433.

The EPA considers the proposal as proposed is environmentally unacceptable as the proposal:

- cannot be managed to meet the EPA's objectives in relation to regional biodiversity conservation (incorporating System 6 areas); and
- is unlikely to be able to meet the EPA's objectives for Declared Rare Flora and priority flora and Groundwater quality, land degradation and related off-site environmental impacts.

As indicated in the EPA's preliminary Position Statement on the protection of native vegetation, the EPA has been concerned about the environmental consequences of agricultural clearing of native vegetation for some time. While the EPA appreciates that there are matters of equity to be considered in decisions relating to clearing of native vegetation, it holds strongly to the view that from an environmental perspective the challenge now is to establish a response to clearing applications in terms of addressing the equity issues rather than to continue to allow further broadscale agricultural clearing.

6. Recommendations

The EPA submits the following recommendations to the Minister for the Environment:

1. That the Minister considers the report on the relevant environmental factors of ,
   a) Regional biodiversity conservation (incorporating System 6 areas);
   b) Declared Rare Flora and priority flora;
   c) Groundwater quality, land degradation and related off-site environmental impacts; and
   d) Greenhouse gas emissions,

   as set out in Section 3.

2. That the Minister notes that the EPA has concluded that the proposal:
   - cannot meet the EPA's objectives in relation to regional biodiversity conservation (incorporating System 6 areas); and
   - is unlikely to be able to meet the EPA's objectives for Declared Rare Flora and priority flora and Groundwater quality, land degradation and related off-site environmental impacts,

   and should not be implemented.

3. That the Minister notes that the EPA has not included in this Bulletin "conditions and procedures to which the proposal should be subject, if implemented" because the EPA holds the view that the proposal should not be implemented.

4. That the Minister not issue a statement that the proposal may be implemented.

5. That the Minister notes the EPA's other advice presented in Section 4 in relation to clearing of native vegetation for exotic single species crops such as Tagasaste.

Appendix 1

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Appendix 2

Summary advice provided by involved agencies within the Level 3 MoU Process

OUTCOME OF LEVEL 3 SUMMARY SHEET - NOTICE OF INTENT TO CLEAR LAND

L 3 Assessment Date: **14th October 1998**

Proponent: REDFORD, Robert

Location: Swan Locations 5434 and 5433, Lot 2
Located on Mogumber West Road, approximately 14 kms east of Brand Hwy, and being approximately 35 kms north of Gingin (Shire of Gingin).

NOI Date: Reassessment of clearing notification received January 1989.

Area Notified: 300 hectares notified – approximately 265 hectares identified

Intended use: sheep and cattle grazing

Issues:

1. Land degradation

Risk of on-site wind erosion if sandy soils are cleared. (Class IV and V soils). Windbreaks and other management strategies required for Class IV soil types.

Potential risk of increased recharge.

2. Nature Conservation

Vegetation provides a corridor (stepping stone) between bush to the south east and the Reserve adjacent the Moore River. Likelihood of priority species occurring on site.

3. Wetlands/drainage

Drainage from the property is in a northerly and north easterly direction across Mogumber West Road towards the Moore River.

Commissioner's (Regulatory) Opinion:

Serious wind erosion hazard (Class IV and V). Risk of increased recharge, resulting in salinity occurring off-site.

IAWG Advice to the Commissioner:

WRC:	Proposal will impact on groundwater level and quality resulting in waterlogging and salinisation. Risk of saline discharge to the Moore River. WRC objects to proposal.
CALM:	Private property not well surveyed. <20% native vegetation.
DEP:	Within System 6 area therefore clearing would require referral to EPA. Vegetation has corridor values and flora values (DRF and priority species in vicinity). Very high species richness. Under represented in conservation estates (<1%).
IAWG:	**Commissioner's intent to object is noted. Property is in System 6 area and will need to be referred to EPA for assessment if objection is reviewed. DEP to contact Mr Redford with regard to System 6 and advise of implications. Potential for RVPS grant – this needs to be conveyed to Mr Redford. Ken Atkins to provide assessment for RVPS purposes.**

LEVEL 3 SUMMARY SHEET - NOTICE OF INTENT TO CLEAR LAND

Department Of Conservation And Land Management Comments

IAWG Meeting Date:	14th October 1998 (19th Meeting)
Proponent:	REDFORD, Robert
Location:	Swan Locations 5434 and 5433, Lot 2 Located on Mogumber West Road, approximately 14 kms east Brand Hwy, and being approximately 35 kms north of Gingin (S of Gingin).
NOI Date:	Reassessment of clearing notification received January 1989.
Area Notified:	300 hectares notified – approximately 265 hectares identified
Intended use:	sheep and cattle grazing

CALM's Interim Advice to the Commissioner:

Advice previously given.

It is understood that the area to be cleared is in the north east corner, and an area south of this is to be retained.

If adjacent vegetation is still intake as appears on some photos, then a local vegetation linkage exists along the eastern side. A corridor should be retained along this side to link with the Moore River to the north and the vegetation blocks running south. This corridor should be wide enough to complement the other vegetation blocks.

No declared rare flora in the area, but some priority flora. These are mainly to the north but this probably due to the surveys along Mogumber West Road. Most of the priority flora is associated with sandy lateritic soils, which appear to be the soils associated with this location.

From the application it appears that the vegetation was chained and burnt on 1992, but it is apparently regenerating well. This could give some potential for regeneration of some of the shorter lived flora.

Given the large area proposed to be cleared, a priority flora survey could be appropriate to determine the best area to be retained to create the corridor in the east.

LEVEL 3 SUMMARY SHEET - NOTICE OF INTENT TO CLEAR LAND

Water and River Commission Comments

IAWG Meeting Date:	14th October 1998 (19th Meeting)
Proponent:	REDFORD, Robert
Location:	Swan Locations 5434 and 5433, Lot 2 . Located on Mogumber West Road, approximately 14 kms east of Brand Hwy, and being approximately 35 kms north of Gingin (Shire of Gingin).
NOI Date:	Reassessment of clearing notification received January 1989.
Area Notified:	300 hectares notified – approximately 265 hectares identified
Intended use:	sheep and cattle grazing

WRC's Interim Advice to the Commissioner:

Groundwater Resource Risk Assessment

The proposed NOI will impact on groundwater level and quality. The impact will be expressed as:

- Increase in the area subjected to water logging, down - slope of the site within Victoria Locations 5433 and 3254 and Reserve 16833, as a result of enhanced recharge to the superficial aquifer with an associated rises in the standing watertable level; and
- Increase in the down slope areas affected by salinisation due to enhanced discharge and subsequent evaporation of groundwater with precipitation and concentration of salt.

This assessment is based upon:

- a deep groundwater table;
- Vertical drainage of recharge to the Yarragadee Formation; and
- Fresh groundwater.

This proposal invokes the policy on clearing regrowth. Nonetheless, the Commission opposes clearing as the property would then support well less than 25% remnant vegetation recommended for the area (only 8.5%), and there is a substantial risk of increased saline discharge to the Moore River. Also the landowner has not demonstrated that heavily grazed tagasaste would be as effective as native bush in controlling local groundwater.

Appendix 3

Extract from EPA ‘Red Book’ Report on Recommended Conservation Reserves in System 6

The recommended area comprises a part of the larger area of open space of regional significance extending along the Moore River (see Figure 1, Chapter 4), an area which is of particular importance as the only major river valley between the Swan and Murchison Rivers.

Recommendations:

C3.1 That our general recommendations on planning and management of Regional Parks be applied to this area (see Recommendations 15 and 16, Chapter 5).

C3.2 That the Department of Fisheries and Wildlife investigate the conservation and the Public Works Department the water supply potential of Reserves C15816 and C25591, and report their findings to the Environmental Protection Authority.

C4 QUINS HILL

The recommended area is situated near the Moore River, about 90km north of Perth, and comprises Swan Locations 5431, 5432, 5433 and lots 101 to 104 of Location 5429, privately owned freehold land (Figure 6).

The area has minor potential for groundwater extraction.

Soil composition within the area varies greatly, from laterite on hill tops to deep sand in valleys. The vegetation is dominated by closed- and open-heaths which are remarkably rich in plant species and are the closest to Perth of the northern heathlands. There are many species of banksia, including three which are unnamed. Dryandra is common, especially on the lateritic soils, and the great variety of heath species, several of which are rare, includes smokebush, myrtle, pea plant, wattle, kangaroo paw, sundew, boronia, snakebush, banjine, leschenaultia and trigger plant. In every season there are wildflowers in bloom, and the area is consequently popular with tourists.

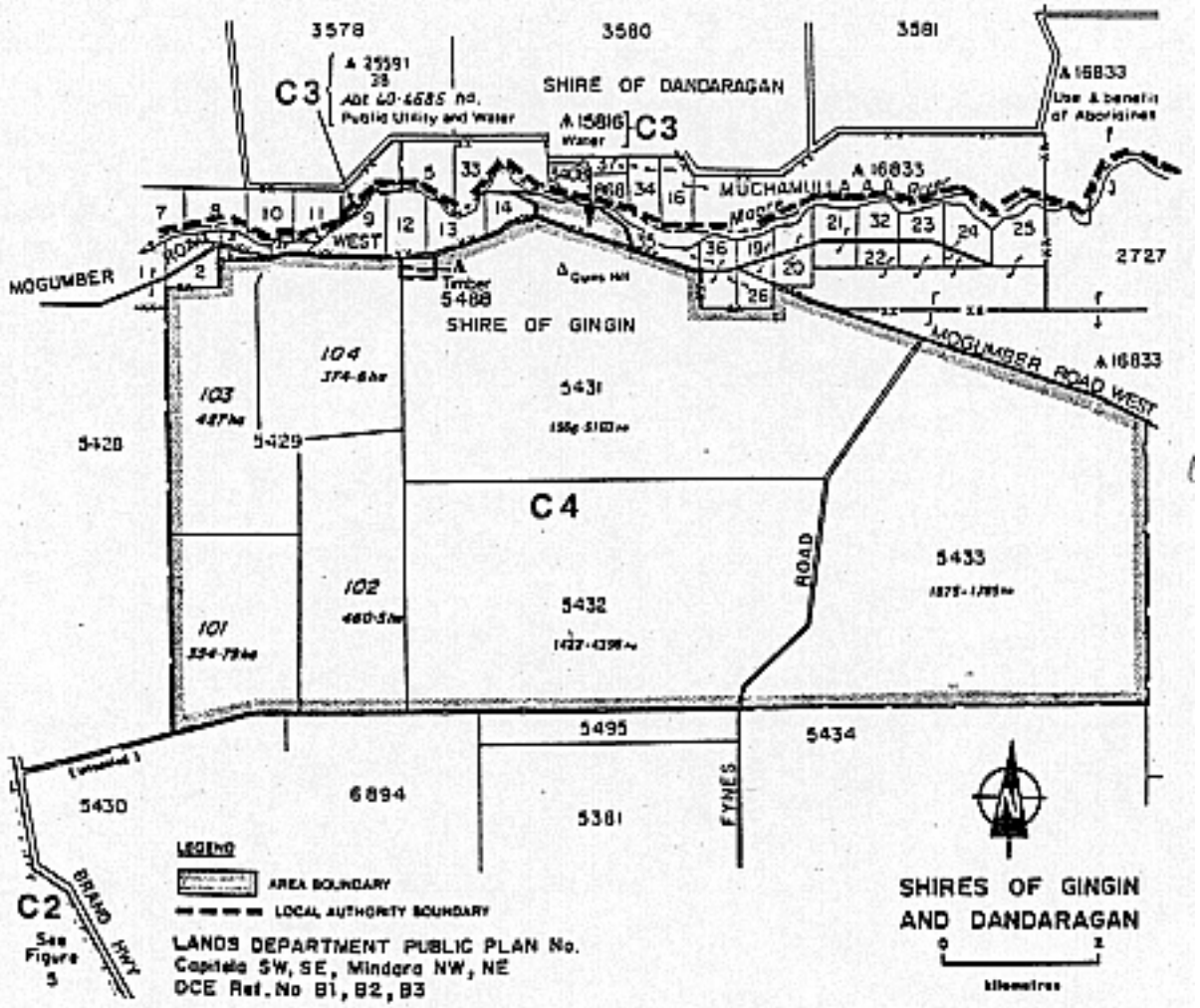

Figure 6

In the sandy valleys there is low open-woodland of pricklybark with some taller marri in places. Banksia is usually associated with this formation. Quins Hill itself is a lateritic hill with both low open-woodland of wandoo and tall shrubland in which Morrison's cypress and broombush honeymyrtle are prominent. The uncommon *Stirlingia simplex* occurs here. The area has a very high conservation value and is important both scientifically and aesthetically. Swan Location 5433 is substantially uncleared, while the other Locations are partially cleared.

The recommended area comprises a part of the larger area of open space of regional significance extending along the Moore River (see Figure 1, Chapter 4), an area which is of particular importance as the only major river valley between the Swan and Murchison Rivers.

Recommendations:

C4.1 That our general recommendations on planning and management of Regional Parks be applied to this area (see Recommendations 15 and 16, Chapter 5).

C4.2 That ways and means of protecting the conservation value of the area be sought through planning procedures to be developed as recommended in Recommendation 14, Chapter 4.

C5 RESERVE A3345, MOORE RIVER

The recommended area is situated in the north-east corner of System 6, about 4km north-west of Mogumber at the junction of the east branch and main stream of the Moore River. It comprises Reserve A3345, for Conservation of Flora and Fauna, vested in the W.A. Wildlife Authority (Figure 7).

The area has limited potential for water supply, but the PWD wishes to retain right of access to the water courses.

The river runs in a valley some 15 to 20m deep, the sides of which support woodland of wandoo, marri and flooded gum. The remainder of the Reserve consists of low sand dunes covered mainly by low open-forest of banksia and pricklybark, with some Christmas tree. There is also some open-woodland of marri, with a well-defined understorey of pricklybark and banksia. On the deeper sand the understorey includes blueboy, silky bloodflower and scrub sheoak.

The Reserve offers a good variety of habitats for wildlife, especially passerine birds. It is important as a type which elsewhere has been mostly developed for agriculture.

Reserve A3345 is one of the few reserves in System 6 that contain representative areas of the Cullala Soil-landform Unit and is easily the largest of all such areas. The Reserve also contains the largest area of the Moore Unit.

The recommended area comprises a part of the larger area of open space of regional significance extending along the Moore River (see Figure 1, Chapter 4), an area which is of particular importance as the only major river valley between the Swan and Murchison Rivers.

Recommendations:

C5.1 That our general recommendations on planning and management of Regional Parks be applied to this area (see Recommendations 15 and 16, Chapter 5).

C5.2 That the purpose and vesting of Reserve A3345 is endorsed.

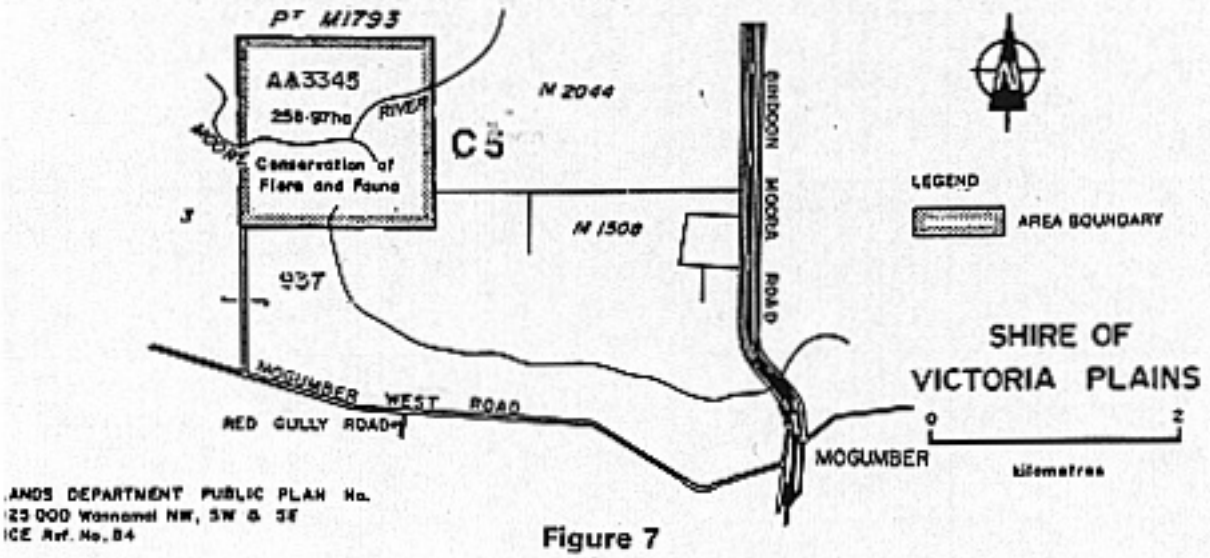

Figure 7

Appendix 4

Calculation of greenhouse gas emissions from proposal to clear native vegetation: Lot 2, Swan Location 5433

Calculation of greenhouse (carbon) emissions: proposal to clear native vegetation: Lot 2, Swan Location 5433, using methodology and data from the National Greenhouse Inventory Committee workbook

Calculation of emissions from proposals to clear native vegetation require several assumptions:

- It is assumed that where vegetation is cleared for agricultural purposes, all burning occurs in the year of clearing;
- The net result from CO_2 uptake during subsequent regrowth is zero;
- If the area was cleared, there is no indication of the portion of the cleared biomass which will be burnt. Some might be burnt in the field to facilitate clearing (on-site burning) and some may be removed and used as fuel (off-site burning);
- A fraction of any material burned on-site is assumed not to be completely oxidised and builds up in the soil as charcoal, undergoing no further CO_2 release; and
- Any aboveground biomass which remains on site but is not burned, will oxidise in approximately a decade.

Estimating Aboveground Biomass:

- Biomass estimates for each forest (vegetation) class vary widely partly because of variation in growth with climatic and soil conditions and also because of the range of species within forest (vegetation) classes;
- Actual values vary even within a State. For example, in the Northern Territory, 'woodland and scrub' biomass changes from about 25t dm (dry matter) / ha near the coast to a lower value in the drier inland, with an average that might be as low as 17.5t dm/ ha[1];
- Intergovernmental Panel on Climate Change (IPCC) default methodology assumes that original aboveground biomass is destroyed after conversion from native vegetation to agricultural lands, 90% occurring immediately and 10% over 10 years. New aboveground biomass is given the default value of 10t dm/ha[2];
- Average estimated before-clearing above ground biomass for 'woodland and scrub' is 21tC/ha[1].

Estimating Below-ground (including roots) Carbon Release:

- Even within one area, the magnitude and rate of loss of soil carbon after the conversion of land with native vegetation to agricultural land is highly variable due to a strong dependence on regional rainfall, soil water and isolated soil physio – chemical characteristics;
- From the limited data available, it is estimated that 30% of soil carbon is lost upon conversion of land with native vegetation to agriculture [1];
- The assumed time span for loss of soil carbon following clearing is 20 years[3] – it is assumed that soil carbon release is linear over the 20 year period (however, the rate of decay will be much faster in (say) the Northern Territory);

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[1] Australian Methodology for the Estimation of Greenhouse Gas Emissions and Sinks, Land Use Change and Forestry, "Workbook for Carbon Dioxide from the Biosphere", Workbook 4.2 Revision 2. National Greenhouse Gas Inventory Committee. Commonwealth of Australia.1997

[2] IPCC 1995 Vol 2

[3] IPCC 1995 Vol 3

- The assumed time span for CO_2 release from decaying roots is 10 years;
- For crops and pastures, the root biomass is assumed to be half of the above ground biomass (default value of 10t C/ha);
- The soil carbon content of unimproved pasture is 50 t C/ha and improved pasture , 62.5 t C/ha; and
- The soil carbon of 'woodland and scrub' is estimated at 70t C/ha.[1]

For calculating the annual CO_2 flux associated with the loss of soil carbon following clearing, it is assumed that soil carbon release is linear over a 20 year period. The rate of carbon released from below-ground (including roots) after land clearing, the area of land clearing is multiplied by the change in soil carbon between a vegetated system and a 20 year old regrowth system, in this case to pasture (The Algorithm for this is located at Section 3.4, page 28, of NGGIC workbook 4.2).

Therefore:

Above-ground biomass carbon is then estimated as 21 tC/ha.
Assume that new pasture aboveground biomass is about 5t C/ha.
Assume 265 ha

Then 16 x 265 = 4240 t C would be emitted by clearing.
90% (3816 t C) would be released immediately and 10% (424 t C) over 10 years.

The below ground biomass soil carbon of 'woodland and scrub' is estimated at 70t C/ha[1]
Assume 265 ha.
Assume that new pasture below-ground regrowth is 10t C/ha.
Assume 30% of soil carbon is lost upon clearing[1].

Then 30% x (70 – 10) x 265 = 4770 t C would be lost from below-ground biomass, in a linear fashion over 20 years after clearing (ie 238.5 t C/yr).

Therefore, total carbon emissions occurring as a result of clearing and conversion to pasture is estimated to be:

3816 t C released immediately, a further 2809 (2385 + 424) released over 10 years and a further 2385 (238.5 x 10) released over the next 10 years ie a total of approx 9010 t C over 20 years.