Review of REF and supporting documentation for Opal Prospecting Areas 1-4 '*Opal Mining within the Narran-Warrambool Reserve, Lightning Ridge Review of Environmental Factors*'

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Review of REF and supporting documentation for Opal Prospecting Areas 1-4 '*Opal Mining within the Narran-Warrambool Reserve, Lightning Ridge Review of Environmental Factors*'

Summary

A Department of Primary Industries press release on Opal Prospecting Area (OPA) 4 [1] notes '*The decision on the establishment of the new Opal Prospecting Area 4, under the provisions of the Mining Act had been reached after exhaustive studies had taken place. This included a major environmental study commissioned by the NSW Government over the Narran-Warrambool Mining Reserve at Lightning Ridge, which provided key environmental information to help manage future development of opal mining and prospecting activities... To ensure future opal prospecting and mining in OPA 4 occurs in an efficient and responsible manner, only a limited number of opal prospecting blocks will be opened up for exploration at any one time. Initially, this will be areas where there are no major environmental issues, or where significant mining activity has already occurred.*' A review of the REF and supporting documents shows that the field surveys, reporting and impact assessments do not show sufficiently clear evidence of areas within OPA 4 where '*there are no major environmental issues*'; additionally, several contradictory statements within the 2004 Parsons Brinckerhoff REF (for example, regarding cumulative impacts) do not engender confidence in the conclusions reached. It is not clear how opening limited numbers of blocks within OPA 4 at any one time will reduce either immediate impacts or the overall cumulative effects of opal mining, particularly on the sensitive Narran Lake system and Ramsar-listed Narran Lakes Nature Reserve.

As detailed elsewhere in this review, in general, the methods, timing and survey effort outlined in the reports reviewed are inadequate, and appear flawed in several respects. Survey methods for threatened flora and fauna species are poorly described, and those descriptions of survey effort that are given suggest inadequate survey effort and, occasionally, a limited understanding of the ecology of those threatened taxa which may occur. In addition, the timing of searches for threatened species is questionable; mention is made of the drought conditions prevailing at the time of the survey, yet the limitations imposed by weather conditions do not appear to have flowed through to the impact assessments. The vegetation mapping for the latter biodiversity assessment does not provide sufficiently detailed information, is not of a scale which allows for interpretation of the results documented in the accompanying report, and is based heavily on 1:100 000 scale mapping supplied by NFRPC (2004); this was based largely on satellite imagery interpretation, a method which Benson *et al.* (2006) note as poor at detecting some communities, including Myall *Acacia pendula* which is listed as an Endangered Ecological Community under the Schedules to the TSC Act 1995. OPA4 extends over 1600 square kilometres. The earlier biodiversity assessment states that flora and fauna was studied within its 500 square kilometre survey area in 20 hours, yet the actual study area (OPAs1-4) outlined in the principal REF measured 3,932 square kilometres. Subsequent surveys undertaken in 2006 were limited to a small fraction of the original survey area (~6,886ha). This suggests that the principle REF provides a synopsis for areas which have not been subject to field assessment.

In light of the above and the uncertainties associated with the impact assessment, it is reasonable to suggest that an EIS is required, which fully considers the potential impacts on biota. An EIS should

1 DPI News Release. 2005. http://www.dpi.nsw.gov.au/archive/news-releases/minerals-and-petroleum/2005/new-opal-prospecting-area

also consider any potential hydrological impacts (no hydrological study has been undertaken [2]) on the sensitive Narran Lake and Ramsar-listed Narran Lakes Nature Reserve. In evaluating the significance of an impact, the Department of Planning [3] state that *the impacts of activities undertaken in environmentally sensitive areas are more likely to be significant than similar activities proposed in less sensitive locations. Relatively small activities carried out in sensitive locations can result in substantial impacts on the environment. A precautionary approach should be adopted for activities proposed in locations known to be environmentally sensitive, including careful investigation of alternative and mitigative strategies.*

While some of the information presented in these documents [4] appears to satisfy several legislative requirements, the limitations of the studies and the conclusions drawn from them raise a number of key issues which have not been adequately addressed. In summary, these are:

- **Inadequate data collection:** in the earlier biodiversity survey and REF [5], the plant species list gives a total of only 73 plant species occurring in a survey area estimated to be in the order of 500 square kilometres (S2.2, p.9), although this report notes that '*the species list is only for rehabilitated, currently mined and one unmined area and is not intended to be a comprehensive list of all the flora species within the Narran-Warrambool Reserve.*' (S4.1 [6]). Subsequent surveys of two properties ('Barfield' and 'Kurrajong') within OPA 4 in 2006 [7] detected a total of 65 plant species in a survey area comprising 6,886 hectares (ha). By contrast, previous unrelated studies restricted to a single sampling event at the Narran Lake Nature Reserve in 2001 [8] in an area of 5,531ha detected a total of 325 vascular plant species (including two species listed under the *Threatened Species Conservation Act 1995*: *Lepidium monoplocoides* and *Goodenia macbarroni*).
- **Inadequate field survey effort:** the BA-2003 survey [9] indicates that only three days in August 2003 were dedicated to field surveys for flora and fauna in an estimated area of 500km^2; this inadequacy is acknowledged in the report (p.2): '*Due to the size of the area being assessed a blanket assessment method for the Narran Warrambool Reserve had to be adopted. In reality this is not an ideal approach as it does not allow for specific searches for threatened species, adequate survey time, or the identification of habitat areas for various species (not all species will use all habitat and this is why the blanket assessment method is not appropriate).*' Those sections of the REF-2004 [10] relevant to ecological issues rely entirely on the results of the BA-2003 survey: while some of the precautionary approaches stated in the BA-2003 report have been adopted in the REF-2004, the limited field survey effort raises questions regarding the reliability of the conclusions reached with respect to the significance (or lack of) of environmental impacts, particularly regarding listed threatened flora and fauna. The BA-2003 report also states that heavy rain occurred during the survey period,

2 Cooperative Research Centre for Freshwater Ecology. 2006. Narran Lakes Scoping Study.

3 Department of Urban Affairs and Planning (Now Department of Planning). 1996. 'Is an EIS Required? – Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979.

4 **(i)** Thompson, L. A., Mullins, B. J. D. & Kent, K. Wagga 2003. Report No. 61 Biodiversity Assessment Narran Warrambool Reserve, Lightning Ridge for Parsons Brinckerhoff Australia Pty. Ltd. Johnstone Centre Research in Natural Resources & Society.

(ii) Parsons Brinckerhoff Australia Pty. Ltd. 2006. Threatened biodiversity Survey and Assessment of Significance: Barfield and Kurrajong, Opal Propecting Area 4, Lightening Ridge. Prepared for NSW Department of Mineral Resource

(iii) Parsons Brinckerhoff Australia Pty. Ltd. 2005. Representations Report: Opal Mining within the Narran-Warrambool Reserve, Lightning Ridge.

5 Thompson above n 4(i).

6 Ibid.

7 Parsons Brinckerhoff Australia Pty. Ltd above n 4(ii).

8 McGann, T. D., Kingswood, R. and Bell, D. 2001. Vegetation of Narran Lake Nature Reserve, North Western Plains, New South Wales. Cunninghamia Vol. 7(1).

9 Thompson above n 4(i).

10 Ibid.

yet the opportunity to use the weather conditions to undertake surveys for frog species was overlooked, even though these weather conditions would probably have provided a rare breeding opportunity for local frog fauna. In the case of the later, more detailed survey within a limited portion of OPA 4 [11], field surveys were restricted to 4 days (BA-2006; Section 4.6.3; Table 4-2): in this relatively short timeframe, vegetation community mapping (provided by Northern Floodplains Regional Planning Committee from work undertaken in 2004) over the entire area (6886ha) was ground-truthed, fauna habitat and general flora surveys were undertaken. However, the potential for threatened fauna species to occur relies on broad habitat-based surveys (already identified in the preceding BA-2003 and REF-2004 as being less than ideal), and the timing and duration of the field surveys clearly restricts the likelihood of detecting many threatened flora and fauna species that are cryptic, ephemeral or only evident during certain seasons. The BA-2006 report notes that field surveys were undertaken following an extended period of drought; however, dry survey conditions alone would not fully explain the poor representation of other faunal groups, particularly reptiles. The low level of survey effort and the reliance on habitat-based assessments and opportunistic sightings in both BA-2003 and BA-2006 give rise to species richness values which are likely to be a considerable under-representation of the flora and fauna assemblages likely to occur within OPA 4, particularly given the likelihood of cryptic or poorly-known species.

- **Inadequate assessment of the significance of impacts on threatened biota:** while the BA-2003 report acknowledges the limitations of its broad habitat-based 'blanket assessment', it nevertheless clearly outlines the likelihood of significant impacts arising from current and proposed opal mining on six threatened fauna species, and further suggests that a Species impact Statement (SIS) would be required unless the results of more detailed survey work indicate otherwise. The REF-2004 clearly advocates further surveys within OPA 4 '*to the level of a Species Impact Statement to assist in developing a biodiversity plan for OPA 4*'. The later BA-2006 for OPA 4, however, despite the likelihood of significant potential impacts as assessed in the REF, concludes that no significant effects on threatened species are likely as a result of opal mining in this area. In addition, the BA-2006 report contains a number of shortcomings beyond the level of survey effort and the restricted range of techniques used. In summary the report:
    - assesses potential impacts on threatened taxa on the basis of a 'moderate level' of mining, without either quantifying 'moderate' or providing evidence that shows this is the most likely scenario;
    - fails to describe and discuss the value of some habitat types for some threatened fauna (*eg. the* potential importance of tree hollows for some of the bat species);
    - fails to fully document the likely consequences of clearing of vegetation, clearing of habitats (*e.g.* ground cover logs and litter and removal of mature trees) on threatened fauna and flora species which are know to depend on those features;
    - fails to assess impacts on several threatened fauna and flora species for which the study area provides potential habitat;
    - fails to acknowledge or assess impacts on a number of EECs which may occur within or near the study area;
    - fails to adopt the precautionary approach [12] given both the limitations of field surveys and the requirement to '*examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity*' [13];

11 Parsons Brinckerhoff Australia Pty. Ltd. above at n 4(ii), 3.

12 See DECC. 2004. Threatened Biodiversity Survey Guidelines (p.3-34) which states: "*It is advised that where adequate surveys have not been conducted within the study area due to limitations, the precautionary principle should always be adopted. This involves* ***assuming that threatened biodiversity which are likely to occur in the study area (based on the presence of suitable habitat and recent records) inhabit the whole of the study area****. The Assessment of Significance would then be conducted on this basis.* (Emphasis added).

13 See s.111 EP&A Act 1979.

- fails to assess cumulative impacts or KTPS;
- fails to either adequately document or assess potential impacts on sensitive environments in the adjacent Narran Lakes Nature Reserve or Narran Lake proper.

- **Decisions made by a state government body to grant an approval or a licence are not deemed an "action"** under s.524 of the EPBC Act 1999 [14]. REF-04 states (S4.3, p 39) that '*Under Section 524* [15] *of the Environment Protection and Biodiversity Conservation Act 1999 [it states that] a decision by a government body to grant a governmental authorisation (however described) for another person to take an action is not an action. This means that the Department of Mineral Resources is not the proponent of opal Opal Mining at Lightning Ridge and that individual miners would be responsible for submitting a referral related to individual actions.* In circumstances where referrals to the Commonwealth Minister for the Environment, Water, Heritage and the Arts are not made by individual licensees, Division 18A of Part 17 of the EPBC Act provides that landholders will be liable to civil and criminal penalties for certain breaches carried out by others on the landholder's land. Given the controlling provisions of the EPBC Act (including Ramsar Wetlands), the DPI needs to clearly outline the steps which would ensure that individual landholders could not be held in breach of the EPBC Act 1999.
- **Retrospective impact assessment within OPAs 1-3:** the ambit of the REF (as defined in Pt1.1, p.1-1) is to assess '*the impacts of current opal mining operations and the potential impacts of operations in a new proposed opal prospecting area (OPA 4). The REF also assesses the effectiveness of existing mitigation measures and safeguards and proposes new or improved measures (where required) to ensure mining can continue to be undertaken in an environmentally sustainable manner*' [16]. In the absence of any preceding impact assessment (*i.e* REF or EIS) for OPAs 1-3, the scope of study provided suggests that the impacts of current opal mining operations were studied and assessed retrospectively. We are unaware of any provisions within the *Environmental Planning and Assessment Act 1979* [EP&A Act 1979] which would enable retrospective assessment.

OBJECTIVES

The objective of this review is to provide a desktop appraisal of the framework Review of Environmental Factors undertaken by Parsons Brinckerhoff Australia Pty. Ltd. and supporting documentation. The appraisal evaluates the following:

- the procedural adequacy of methods employed, including survey timing, effort and considerations;
- the accuracy and completeness of information supplied;
- the conclusions drawn regarding likely impacts and whether those conclusions are based on sound assumptions;
- the adequacy of ameliorative and mitigative measures; and

14 Compliance and enforcement clauses in the Act encompass numerous factors, but do not identify non-referral of developments or activities where "matters of national environmental significance" may be affected: the rights of third parties to report non-referral are not recognised by the Act and subordinate legislation. Even if it is clear that the action of a proponent would trigger the requirement for impact assessment under the EPBC Act, members of the public cannot refer that action to the Minister.

15 A decision by a state government body to grant an approval or a licence) is not an action under the EPBC Act Environment Protection and Biodiversity Conservation Act 1999 Act No. 91 of 1999 as amended s.524 Things that are not *actions*

16 Parsons Brinckerhoff Australia. 2004. Review of Environmental Factors: Opal Mining within the Narran Warrambool Reserve, Lightning Ridge. Prepared for NSW Department of Mineral Resources. p 1-1.

- an assessment of whether the reports adequately addresses the requirements of relevant legislation and provides appropriate assessments of significance pursuant to s5A of the EP&A Act 1979.

Although it is possible to provide some general guidance with regard to the provision of habitats in OPA4 for species listed in NSW [17] and nationally [18], it is important to note that a desktop review can only draw conclusions relating to the procedural adequacy of the survey and reporting. A review of this type cannot determine whether the presence of threatened species, ecological communities or other factors have been overlooked during the REF process or during subsequent studies.

Division 3 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) sets out the circumstances where an EIS is required. Under Part 5 of the EP&A Act, an EIS will be required where an activity is likely to 'significantly affect the environment'. Interpretation of this matter may be found in the DUAP publication '*Is an EIS Required?*' [19] which has been used as guidance material in this review.

2.0 OVERVIEW OF SURVEY AREA

The Central Lowlands and the South Australian Ranges

The Narran River and its associated wetlands lie within the broader Central Lowlands and South Australian ranges region of Hatton and Evans [20], who describe the region thus:

> This region is an extensive basin(s) of inland drainage covering Central and South-Western Queensland, North-Eastern South Australia and North-Western New South Wales. From its wetter, Eastern margin, rivers feed permanent lakes and swamps such as the Macquarie Marshes. This region also includes the Channel Country, which has extensive floodplains and barlkarras... Finally, the region contains most of the artesian features of the Great Artesian Basin known as mound springs. There are few (naturally) permanent lakes. Narran Lake, near Brewarrina, is the terminal drainage basin for the Narran River (a distributary of the Balonne River); it supports canegrass (*Eragrostis australasica*) and *Phragmites* grasslands, and *Lignum* shrublands. The role of groundwater in maintaining this system is not known... Many such systems have connection to the regional groundwater table, but it is not possible to provide a synoptic assessment of the importance of this connection across the wetlands of the region. Intermittent floodplain lakes are common but are assumed to have no significant dependence on groundwater. [21]

Narran-Warrambool Reserve

The Lightning Ridge Mineral Claims District/ Narran-Warrambool Reserve is gazetted as a mineral claims district in accordance with the provisions of the *Mining Act 1992* [22]. The Reserve consists of a number of Opal Prospecting Areas (OPA), within which land is made available for opal prospecting. The bounds of currently mined lease areas (OPAs 1-3) and prospective lease areas (OPA 4) are shown in Appendix 1. The Narran-Warrambool Reserve is located in the Darling-Riverine Plains Bioregion (Interim Biogeographic Regionalisation of Australia (IBRA))[23]. Approximately 88% of this Bioregion (9,394,263 ha) occurs within NSW; it is part of the Murray-Darling Basin, is included in the NSW

17 *Threatened Species Conservation Act 1995*.

18 *Environment Protection and Biodiversity Conservation Act 1999* (Cwth)

19 *Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979* (Department of Urban Affairs and Planning 1996)

20 Hatton, T. and Evans, R. 1998. 'Dependence of Ecosystems on Groundwater and its Significance to Australia'. CSIRO Sinclair Knight Mertz, LWRRDC Occasional Paper No 12/98.

21 Note that Hatton and Evans (1998) later (p.25) state "*It has only been in the last two decades that Australian science has begun to appreciate the extent and degree of dependence of non-wetland vegetation on groundwater... Gaps remain, however. We have a relatively poor understanding of how adaptive vegetation is with respect to changing the depth, quality and regime of groundwater.*"

22 *Mining Act 1992*, s.173; s.367

23 See Interim Biogeographic Regionalisation of Australia (IBRA) v6.1 accessed 02/05/2008 at:
http://www.environment.gov.au/parks/nrs/science/bioregion-framework/ibra/index.html

Western Plains botanical subdivision, and occurs within the Western Catchment Management Authority area [24].

Narran Lakes and Narran Lake Nature Reserve - Ramsar Site No. 995

The Narran Lake Nature Reserve is a listed Ramsar Wetland (No. 995)[25] extending over an area of 5,538 hectares [26]; it is managed by the NSW National Parks and Wildlife Service (NPWS - part of DECC), who also manage a further 3,547 ha of land adjoining the south-eastern boundary of the Reserve [27]. The site was listed on the following Ramsar Criteria: 1a, 2c, 3c [28]; further descriptions of the Narran Lake Nature Reserve listing are provided in Appendix 3. The Ramsar Convention obliges its contracting parties to ensure that the natural and cultural heritage values of listed wetlands are maintained and, where necessary, enhanced.

The Narran Lake Nature Reserve covers approximately 1/3rd of a large system of terminal wetlands of the Narran River. These wetland areas (including the Nature Reserve, Narran Lake and extensive channel systems) are internationally significant for waterbird breeding and as habitat for a number of species listed under the Japan-Australia, China-Australia Migratory Bird Agreements and the Republic of Korea-Australia Bird Agreement (JAMBA, CAMBA and ROKAMBA): these Agreements are aimed at the protection of those migratory bird species and their habitats listed in the Agreements. According to the Murray-Darling Basin Commission [29], the Narran Lakes and swamps "*... cover a total area of some 10,000 hectares... When full, Narran Lake is one of the largest freshwater lakes in the state. Located in a semi-arid region, the area floods after heavy rain in the headwaters of the river system in southern Queensland. This occurs about once every two to five years. After flooding, water may persist in the lake for up to two years... Following flooding, there is a large influx of waterbirds to the area, and many species breed. Very large nesting colonies of straw-necked ibis* (Threskiornis spinicollis) *sometimes occur in the swamps. Large concentrations of ducks occur on the lake as water recedes, as well as pelicans and black swans.* [30; 31]."

The Nature Reserve also contains a variety of flora associations which are considered to be threatened in NSW [32]. The Murray-Darling Basin Commission notes "*The swamps are vegetated with dense lignum, together with river cooba* (Acacia stenophylla) *and coolibah* (Eucalyptus microtheca) *along the river banks, while the lakes are bordered with annual saltbush and copperburrs... Narran Lakes and the associated wetlands remain in relatively natural condition, and are thus representative of the large terminal drainage wetlands which occur in semi-arid NSW. However, over recent years, together with wetlands upstream in both New South Wales and Queensland, the area has come under serious threat as a result of water extraction developments in Queensland, primarily for cotton growing...*

24 See http://www.environment.nsw.gov.au/bioregions/DarlingRiverinePlainsBioregion.htm

25 The Convention on Wetlands (Ramsar, Iran, 1971) – listing criteria for sites listed pre-May, 1999.

26 Department of the Environment, Water, Heritage and the Arts Australian. 1999. Wetlands Database/ Ramsar Wetland description

27 NPWS. 2000. Narran Lake Nature Reserve: Plan of Management. NSW NPWS, Hurstville.

28 **1. Criteria for representative or unique wetlands** (a) it is a particularly good representative example of a natural or near-natural wetland, characteristic of the appropriate biogeographical region; or **2. General criteria based on plants or animals** (c) it is of special value as the habitat of plants or animals at a critical stage of their biological cycle; or **3. Specific criteria based on waterfowl** A wetland should be considered internationally important if: (c) where data on populations are available, it regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl.

29 See Murray-Darling Basin Commission pages at: http://www.mdbc.gov.au/nrm/water_issues

30 ANCA. 1996. A Directory of Important Wetlands in Australia. Second edition. Australian Nature Conservation Agency, Canberra.

31 Brooker, M.G. 1993. Aerial counts of waterbirds on Narran Lake, NSW. *Australian Bird Watcher*, 15, 13-18.

32 Department of the Environment, Water, Heritage and the Arts Australian above n 24, 6.

The consequent reduced flows and the loss of small to medium size flood flows have already affected the wetlands and the use of the area, in the dry phases following flooding, for grazing..." [33]

Narran Lake is the terminal wetland for the Narran River. Thoms *et al.* (2006)[34] note that "*The hydrology of the* [Narran Lakes] *system means that when flows from Narran River cease the water level will fall in these two smaller lakes* [Back Lake and Clear Lake]... *as the water flows into Clear and Back Lake, water continues along Narran River and finally into Narran Lake. Once Narran Lake is full it can retain water for up to two years, and is one of the largest freshwater lakes in NSW*." While Narran Lake contains significant ecological values, it is neither part of the Narran Lake Reserve nor is all of the Lake included in the Ramsar listing.

Native Vegetation of the Western Plains region

In the most comprehensive study of vegetation of the NSW Western Plains undertaken to date, Benson *et al.* (2006)[35] describe 213 plant communities in the Western Plains: 86 of these occur in the Darling-Riverine Plains Bioregion. Only 83 protected areas occur in the entire Western Plains, protecting a mere 3.7% of the area (less than half the State average). The great majority of the plant communities in the Western Plains area are poorly represented in protected areas.

At a finer, regional scale, vegetation within the Northern Floodplains of NSW was classified by the Northern Floodplains Regional Planning Committee in 2004; classification was based on the use of satellite imagery and field checking, and the resultant reports and vegetation mapping divide the Northern Floodplains into three divisions: the Walgett Shire, Brewarrina Shire and the north-eastern part of Bourke Shire. The vegetation mapping for the first of these divisions (Walgett Shire) is that used by Parsons Brinckerhoff for the REF and the Biodiversity Assessment.

3.0 LEGISLATIVE FRAMEWORK

The Lightning Ridge Mineral Claims District/ Narran-Warrambool Reserve is gazetted as a mineral claims district in accordance with the provisions of the Mining Act [36]; mining is considered to be ancillary to the consent provisions of local Environmental Planning Instruments [37]. Mineral claims must be approved by the Minister for Primary Industries [38] and are subject to environmental assessment [39] in accordance with the provisions of Part 5 of the EP & A Act 1979 [40]. In doing so, the determining authority must take into account, '*to the fullest extent possible'* [41], the environmental impacts of the activity [42]; if the activity is likely to have a significant impact on the environment [43],

33 Murray-Darling Basin Commission at http://www.mdbc.gov.au/nrm/water_issues/wetlands.

34 Cooperative Research Centre for Freshwater Ecology above at n 2, 2.

35 Benson J., Allen C.B., Togher C. and Lemmon J. 2006. New South Wales Vegetation Classification and Assessment: Part 1 Plant Communities of the NSW Western Plains. *Cunninghamia* 9(3) (2006), pp. 383-450.

36 *Mining Act 1992*, s.173; s.367.

37 Brewarrina Local Environmental Plan. 2000. Schedule 5: Narran Lake Nature Reserve Narran Lakes Ramsar Site zoned Environmentally sensitive land; and Walgett Interim Development Order No. 1.

38 *Mining Act 1992*, s. 13(4); s.41; s.63; s.228.

39 *Mining Act 1992*, s.237; s.238.

40 *Environmental Planning and Assessment Act 1997*, s.111.

41 *Environmental Planning and Assessment Act 1997*, s.111.

42 including, but not limited to:

(2)(b) any plan of management adopted under that Act for the conservation area to which the agreement relates;

(4)(b) in the case of threatened species, populations and ecological communities, and their habitats, whether there is likely to be a significant effect on those species, populations or ecological communities, or those habitats, and

(c) any other protected fauna or protected native plants within the meaning of the *National Parks and Wildlife Act 1974*.

the proponent must prepare an Environmental Impact Statement [44]. Similarly, if the activity is likely to have a significant impact on a listed threatened species, the proponent must prepare a Species Impact Statement [45].

Despite the legislative requirements, the REF recommends that *conservation planning study* be undertaken *such that there is no significant impact on threatened species or cultural heritage* (S7.2.2, p. 99):

> *The current large-scale assessment of environmental impacts has suggested that there may be significant impacts associated with opal mining in OPA 4 on flora and fauna and cultural heritage. It is therefore recommended that further investigations be undertaken in order to plan for the opening of OPA 4 such that significant impacts are avoided as is the need for an Environment Protection and Biodiversity Conservation Act referral or a Species Impact Statement at the level of a mineral claim. Because of the vast size of Opal Prospecting Area 4, it is proposed that a three stage approach is taken to the assessment of impacts.*
>
> ***Stage 1:*** *This would include a biodiversity and conservation planning study undertaken in consultation with the Commonwealth Department of Environment and Heritage and the NSW Department of Environment and Conservation such that there is no significant impact on threatened species or cultural heritage. It is envisaged that these studies would identify areas of sensitivity within OPA 4 in which opal mining should not be allowed, areas in which mining could potentially proceed with further investigation and areas of low sensitivity in which mining could proceed. Areas of vegetation of high conservation value should be identified and set aside for conservation in a way that ensures each of the four main vegetation types listed in this report remain connected by one or more corridors of vegetation. This will ensure that at least some areas of each type of vegetation community are conserved in a high quality state.*

It is difficult to determine whether the intended *biodiversity and conservation planning study* (*i.e.* Stage 1) recommended was subsequently provided in the form of a biodiversity assessment [46], or whether these surveys (limited to ~6,886ha on the properties of Barfield and Kurrajong) undertaken in constitute the recommendations provided in Stage 2.

> ***Stage 2:*** *More detailed studies in smaller portions of Opal Prospecting Area 4 prior to these areas being opened to better identify areas of sensitivity.*
>
> ***Stage 3:*** *A checklist environmental assessment carried out by the miners at the time of lodging a mineral claim and reviewed by staff of the Department of Mineral Resources. The checklist should include:*
>
> - *the location of the claim, to be checked against the environmental assessment of*
> - *the Opal Prospecting Block;*
> - *the number of trees above a set diameter (as an indication of vegetation health);*
> - *an indication of vegetation to be cleared;*
> - *a mud map of the site including drainage lines and access tracks; and*
> - *an assessment of clearly identifiable cultural heritage artefacts.*
>
> *While it will be the responsibility of the miner to complete the checklist, it should be assessed by the Department of Mineral Resources environmental officer based on information contained in the environmental assessment of the Opal Prospecting Block. Random checks of information provided should be made in the field. If necessary, further information should be requested prior to granting of a mineral claim. An example of the checklist assessment is provided in Appendix F.*

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43 *Environmental Planning and Assessment Act 1997*, s.4 Definitions: *environment* includes all aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings.

44 *Environmental Planning and Assessment Act 1979*, s.112; s.229 - s.232.

45 *Environmental Planning and Assessment Act 1979*, s. 112 (1B).

46 Parsons Brinckerhoff Australia Pty. Ltd. above at n 4 (ii), 3.

4.0 PROCEDURAL ADEQUACY OF METHODS EMPLOYED

4.1 Broad Overview of Documents Reviewed

This review examines the Review of Environmental Factors [47] and supporting documents [48]. A summary of the extent of survey, including survey timing, effort and considerations is provided below:

1. Parsons Brinckerhoff Australia. 2004. Review of Environmental Factors: Opal Mining within the Narran-Warrambool Reserve, Lightning Ridge. Prepared for NSW Department of Mineral Resources.

This document provides a framework for the environmental impact assessment process of future mineral claims within the gazetted mineral claims district of Narran-Warrambool Reserve, Lightning Ridge. It also provides for the assessment of the impacts of current opal mining operations and the potential impacts of operations in a new proposed opal prospecting area (OPA 4). It also assesses the effectiveness of existing mitigation measures and safeguards associated with operations within OPAs 1-3 and proposes new or improved measures for all OPAs, but mostly for OPA4. The ecological assessment (see Point 2 below) forms appendix D. The reported survey area is not defined in the REF but the title *Opal Mining within the Narran-Warrambool Reserve, Lightning Ridge* implies that the complete reserve was considered. The REF (S1.2, p.14) outlines OPAs 1-4 as having a total extent of 3,932 square kilometres.

The ambit of the REF as defined in Pt1.1 is to assess '*the impacts of current opal mining operations and the potential impacts of operations in a new proposed opal prospecting area (OPA 4). The REF also assesses the effectiveness of existing mitigation measures and safeguards and proposes new or improved measures (where required) to ensure mining can continue to be undertaken in an environmentally sustainable manner*' [49]. In the absence of any preceding impact assessment, this suggests that impacts of current opal mining operations were assessed retrospectively. We are unaware of any provisions within the Environmental Planning and Assessment Act 1979 [EP&A Act 1979] which would enable this type of assessment [50].

This document is referred to hereafter as the 'REF-2004'.

2. Thompson, L. A., Mullins, B. J. D. & Kent, K. Wagga 2003. Report No. 61: Biodiversity Assessment Narran-Warrambool Reserve, Lightning Ridge for Parsons Brinckerhoff Australia Pty. Ltd. Johnstone Centre Research in Natural Resources & Society.

The report documents the findings of a desktop and field survey conducted on the 12th – 15th August 2003. The document provides details the species, populations and communities of flora and fauna occurring within the gazetted mineral claims district of Narran-Warrambool Reserve and the proposed Opal Prospecting Area 4 (OPA4) and provides an assessment of existing habitat. The reported survey area is estimated to be in the order of 500 square kilometres (S2.2, p.9), and given that it promotes the same survey coverage as the REF, the geographic area is markedly less that the extent of survey implied in the REF (3,932 square kilometres).

47 Parsons Brinckerhoff Australia Pty. Ltd above n 5, 3.

48 **(i)** Thompson above n 4(i), 3; **(ii)** Parsons Brinckerhoff Australia Pty. Ltd. above at n 4(ii), 3; **(iii)** Parsons Brinckerhoff Australia Pty. Ltd above n 4(iii), 3.

49 Parsons Brinckerhoff Australia Pty. Ltd above n 5, 3.

50 Environmental Planning and Assessment Act 1979, ss.112 (1B).

A review of potential impacts on threatened species is provided. Meliorative measures are also provided to minimise the impact of the OPA4 proposal on the natural environment. The report details rehabilitated and non-rehabilitated mining sites within OPAs 1-3 which were surveyed for flora and fauna, as well as rehabilitation success. The methods describe '*a site survey and reconnaissance was undertaken within OPA 4'*, suggesting a general, broad-stroke survey method. The methods also describe the survey limitations '*Due to time constraints within the project as a whole, surveys were conducted outside the optimal survey season (September – November).*'.

Heavy reliance is placed on the vegetation types described in the *Draft Walgett Regional Vegetation Management Plan* [51], although the REF (footnote, p 68, S6.3) identifies its status as *'The Draft Walgett Regional Vegetation Management Plan was prepared by the former Department of Land and Water Conservation and the Walgett Regional Vegetation Committee. Regional Vegetation Committees have now been disbanded and replaced by Catchment Management Authorities. This means that the Vegetation Management Plan will not be implemented in its current form. New vegetation mapping is now available from Department of Infrastructure, Planning and Natural Resources, but was not available at the time of writing.'*.

A number of caveats describe the limitations of the study as (i) Due to time constraints within the project as a whole, surveys were conducted outside the optimal survey season (September – November). To compensate for the limitations associated with the timing and duration of the survey flora and fauna data from the NSW National Parks and Wildlife Service database was obtained for the Lightning Ridge Map Sheet (8439) as well as the Walgett Local Government Area (LGA). A total of 3 days was spent in the field with approximately 20 person hours being utilised for targeted flora and fauna searches (S3.0, p.15).

This document is referred to hereafter as the 'BA-2003'.

3. Parsons Brinckerhoff Australia. 2006. Threatened biodiversity Survey and Assessment of Significance: Barfield and Kurrajong, Opal Propecting Area 4, Lightening Ridge. Prepared for NSW Department of Mineral Resources.

This survey is limited to ~6,886ha of two properties in OPA4, Barfied and Kurrajong. Survey effort was largely limited to six sites (see Appendix 1 – survey sites shown as red, bold crosses) between 30th and 31st January 06 and 1st and 2nd February, 2006 (*ie.* over 4 days). Despite the title of the document, the methods describe a general survey, with ground-truthing of previously mapped vegetation undertaken at six sites '*while driving or walking along tracks'* being undertaken over 80 hours (in the 4 day survey period).

A number of caveats describe the limitations of the study as (i) largely based on habitat; (ii) surveys were undertaken during extended and extreme dry weather periods when some fauna and ephemeral plant species may not have been detectable. Consequently, the authors assert that the results are merely indicative of the conditions prevalent on the site at the time of the surveys.

This document is referred to hereafter as the 'BA-2006'.

4. Parsons Brinckerhoff Australia Pty. Ltd. 2005. Representations Report: Opal Mining within the Narran-Warrambool Reserve, Lightning Ridge.

This report responds to representations received from the public display of the Review of Environmental Factors (REF) for the Narran-Warrambool Reserve study. It provides a description of

51 DLWC. 2002. *Draft Walgett Regional Vegetation Management Plan*, Department of Land and Water Conservation, New South Wales.

the background to this proposal, a detailed breakdown of the representations received and consideration of the issues raised by the respondents. The report addresses issues raised in the representations and outlines modifications in the form of additional or amended management and mitigation measures. The document relies on previous reporting (*i.e.* 1 and 2 above).

This document is referred to hereafter as the 'REP-2005'.

4.2 Survey Effort, Methods and Findings Assessments of Significance

A summary of the survey methods used and limitations posed by prevailing conditions for each of the surveys is provided below in Table 1, with discussion provided below. NB OPA4 extends over 1600 square kilometres.

Table 1 showing a summary of methods defined in the REF and supporting documentation.

Study	Area	Methods and limitations			
		Mammals	**Birds**	**Herpetofauna**	**Plants/ Other**
Parsons Brinckerhoff Australia. 2004. (REF-04)	The REF (S1.2, p.14) outlines OPAs 1-4 as having a total extent of **3,932 square kilometres**. Given the document title, aims and discussion provided in the document, this area is assumed to be the study area.	N/A	N/A	N/A	N/A
Thompson, L. A., Mullins, B. J. D. & Kent, K. Wagga 2003. (BA-03)	**500 square kilometres** (S2.2, p.9)	Adverse weather conditions, including strong winds and heavy rain, during the survey period prevented the survey of bats and nocturnal mammals. No targeted surveys were conducted for mammals during the survey (S3.2.2, p16).	Seven bird surveys of at least twenty minutes each were undertaken at mined, unmined and rehabilitated sites… Five surveys were undertaken in rehabilitated mining areas with one in an active mining area and one in the unmined area of OPA 4. Incidental sightings during reconnaissance in the field over the three days were also recorded.	No targeted surveys were undertaken for reptile or frog species. The cool conditions meant that reptile activity was low and the absence of permanent water in most areas limits the distribution of amphibians. Incidental sightings were recorded.	No methods described
Parsons Brinckerhoff Australia. 2006. (BA-06)	**~6,886ha**	Spotlighting, Koala habitat assessment and Anabat detection at six locations within OPA4, (Barfied and Kurrajong) while walking or driving	Call playback and observations were used at six locations within OPA4, (Barfied and Kurrajong) while walking or driving.	No targeted surveys were undertaken for reptile or frog species. Diurnal searches were used at six	Vegetation mapping ground-truthed at six locations while walking or

		(S3S4.1, p15).		locations within OPA4, (Barfied and Kurrajong) while walking or driving.	driving. Soil plots collected at six locations.

Survey Effort and Methods – Flora and Vegetation Communities

1) BA-2003 (Thompson *et al.*, 2003).

As noted in Table 1 above, other than stating that field surveys took place in August 2003, BA-03 gives no indication of field survey effort for either flora species or ecological communities: field survey methods are not described, locations of field surveys are not provided (other than general statements regarding the survey area), and there is no mention of the methods, locations or intensity of any targeted surveys for threatened flora taxa.

2) BA-06 (the "Barfield and Kurrajong report")

REF-06 states that existing vegetation mapping (provided by the Northern Floodplains Planning Committee 2004) was 'ground-truthed', though the description of the methods used to determine the validity and the extent of the vegetation communities as previously mapped is restricted to a single statement noting the use of a hand-held GPS. Despite the claims regarding the ground-truthing of existing mapping and the '*real location confirmation of vegetation boundaries* [sic]', the resulting vegetation maps for the Barfield and Kurrajong sites are identical with those provided in the NFPC (2004): given the large area covered and its native scale of 1:100 000, vegetation community mapping is probably too coarse to be either accurate or informative at the scale of the survey sites in the 2006 Parsons Brinckerhoff report. The NFPRC (2004) vegetation mapping also shows a number of local variations in the most widespread of the vegetation communities (their 'Poplar Box/ Pine / Other'), none of which are mentioned in BA-06.

With respect to individual plant species, the BA-06 report states that plant species were "assessed" using the Random Meander techniques of Cropper (1993) [52]; however, it does not describe where these plant surveys were undertaken; importantly, it does not state which methods (if any) were used to detect threatened plant species, or whether areas of potential habitat for threatened species were defined or searched. One of the few statements in REF-06 regarding flora survey effort notes '*The time spent in each vegetation community is generally proportional to the size of the community and its species richness*': flora survey methods described in creditable methodologies [53] point out that the number of plant species detected within a fixed area will increase with longer survey periods.

Given the size of the area surveyed in BA-06 (6886ha - ~ 8 x 8km) and that the impact assessments relied heavily on field data, a total of 4 days survey effort is not likely to be sufficient, particularly given that only a fraction of the survey period is likely to have been dedicated to flora surveys and vegetation community delineation; the only reference to timing and duration of flora surveys is found in Table 4.2 in Section 4.6 (Fauna). While not mandatory, the best available recommendations for field survey methods, timing and duration are found in the *Threatened Biodiversity Survey and Assessment: Guidelines for Development and Activities* (DEC 2004). Section 5.2 (Plants) suggests the following:

- survey area stratified to "*ensure that the full range of potential habitats and vegetation types* [is] *systematically sampled*"; each stratification unit should be sampled to a level sufficient to discern habitat heterogeneity

52 Cropper, S. 2003. Management of Endangered Plants. CSIRO Publishing.

53 See DECC 2004 Fig 5.1, also p.5-71 and associated references.

- **minimum survey effort** – for each stratification unit, either traverses or plots (or a combination) be undertaken as follows:
    - 10x100m traverses per 501-1000ha of stratification unit, plus one additional 100m traverse for each extra 100ha thereof, **plus** 30 minutes random meander for each traverse to enable detection of threatened species; and/or
    - 10x100m quadrats per 501-1000ha of stratification unit, plus one additional quardat for each extra 100ha thereof.

Variations on the above are acceptable in more uniform landscapes (such as the slopes and plains of western NSW), where larger plot and traverse dimensions are thought to be required to compensate for the heterogeneity of vegetation. The guidelines also note that habitat assessment for threatened species should note where surveys have been undertaken beyond the optimal seasons for particular threatened species or where detection may be rendered unlikely due to climatic conditions (such as extended drought).

With respect to the season of survey, existing literature notes that many plant species (including threatened taxa) are unlikely to be detected during certain seasons or during extended drought periods. Burrows (2004)[54] states that, in the South and Central Western Slopes divisions of NSW, vegetation surveys conducted in mid- to late summer, autumn and winter may account for less than half of the total number of species present at a site, predominantly due to the large number of ephemeral, annual and herbaceous species in the groundcover layer. Additionally, Burrows suggests that the optimal period for 'one-off' surveys is mid to late spring; even if surveys are conducted during this period, the characteristically unpredictable rainfall patterns in the western divisions of NSW can have a significant bearing on the abundance and range of species detected, and it is strongly recommended that the results of flora surveys are accompanied by details of rainfall data for "…*at least the previous 2 to 3 months for the site or the surrounding area and an indication of how this compares to the long-term average.*'

4.2.1 Threatened Species, Populations and Ecological Communities Considered

The *Threatened Species Conservation Act 1995* (TSC Act) has modified the *Environmental Planning & Assessment Act 1979* (EP&A Act) by including a requirement in Section 5A (s.5A) to determine "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*". The seven factors of s.5A "*must be taken into account*", particularly in administering Sections s.78, s79, s.111 and s.112 of the EP&A Act and consequently in determining whether a Species Impact Statement is required.

4.2.1.1 Flora

Although a search of a relevant wildlife database (such as the NSW NP&WS Atlas of NSW Wildlife Atlas database) is not obligatory, such a search is a highly useful tool in ascertaining the likelihood of the presence or absence of conservation significant species on a site, and in determining potential habitat for such species on the site. A current search of the NP&WS Atlas of NSW Wildlife database and the generation of an EPBC Environmental Report reveals the potential for six threatened flora species and forty threatened fauna species within a 50km radius of the site, and the potential for six ecological communities within the Darling Riverine Plains Bioregion (see Appendix 1 and discussion below).

Descriptions of methods in all three reports suggest that no specific (targeted) searches were provided for threatened flora species. BA-03 [55] states that '*Due to the size of the area being assessed a blanket*

54 Burrows, G.E. 2004. 'Seasonality in the timing of vegetation surveys'. *Cunninghamia* 8(4): 514-520, 2004.

55 Thompson above n 4(i), 3.

assessment method for the Narran Warrambool Reserve had to be adopted. In reality this is not an ideal approach as it does not allow for specific searches for threatened species, adequate survey time, or the identification of habitat areas for various species (not all species will use all habitat and this is why the blanket assessment method is not appropriate).' The authors fail to provide any reference the *blanket assessment* approach. In their findings, the authors state that '*Currently, there are no endangered ecological communities within the Narran-Warrambool Reserve*', but fail to state:

- how the '*blanket assessment*' approach used is conducive to the detection of such communities; or
- whether other methods were used to determine the presence of vegetation communities of conservation significance.

Where field surveys of a particular site are limited or restricted in scope, DEC Threatened Biodiversity Survey Guidelines (DEC 2004, p.3-34) urge the use of caution: '*It is advised that where adequate surveys have not been conducted within the study area due to limitations, the precautionary principle should always be adopted. This involves assuming that threatened biodiversity which are likely to occur in the study area (based on the presence of suitable habitat and recent records) inhabit the whole of the study area. The Assessment of Significance would then be conducted on this basis.*'

The species list from BA-03 [56] comprises a mere 73 plant species detected in a survey area estimated to be in the order of 500km^2 (S2.2, p.9), although the author of the earlier report states that '*the species list is only for rehabilitated, currently mined and one unmined area and is not intended to be a comprehensive list of all the flora species within the Narran-Warrambool Reserve.*' (S4.1 [57]). Subsequent surveys (BA-06) [58] detected a total of 65 species in seven vegetation communities in a survey area of two properties in OPA4, "Barfield" and "Kurrajong". By contrast, previous studies in survey areas in the Western Plains have documented significantly higher levels of plant diversity, for example:

- in a single sampling event at the Narran Lake Nature Reserve, McGann *et al.* (2001) [59] detected relatively high species richness compared to other western NSW reserves; a total of 325 vascular plant species were recorded (including two species listed under the *NSW Threatened Species Conservation Act 1995* - *Lepidium monoplocoides* and *Goodenia macbarroni*). An additional 11 species are considered to be at their geographic limit or disjunct in their distribution;
- Benson *et al.* (2006) list more than 60 species alone from two Poplar Box-dominated vegetation communities, 63 species in Mulga Shrubland, and 37 species in White Cypress Pine woodland. All of the communities referred to in Benson *et al.* (2006) appear to bear strong resemblances to those described in the Barfield and Kurrajong report (BA-06); however, note that there will be some overlap in species between communities.

It is possible that the detection of low species diversity is an effect of weather conditions, especially extended periods of drought. BA-06 mentions '*prolonged*' and '*significant*' drought as an influence on the number of fauna species detected; however, the significance of the extended drought in the area is not mentioned as a possible factor in low levels of plant species diversity where the condition of vegetation communities is being evaluated. As mentioned above, the effects of the duration, frequency and seasonal timing of surveys on detection rates of plant species are important factors not often considered in assessments of vegetation communities in the Western Slopes and Plains divisions, and these considerations become even more important where surveys are undertaken during or just following prolonged drought periods. It is quite likely that further, more detailed flora surveys would have revealed a significant increase in flora species diversity, especially where those surveys were

56 Ibid.

57 Ibid.

58 Parsons Brinckerhoff Australia Pty. Ltd. above at n 4(ii), 3.

59 McGann above n 9, 3.

undertaken in different seasons (*e.g.* late spring, as recommended by Burrows [2004]) or after good rainfall; as Burrows (2004) notes, many threatened flora species in the Western Slopes region are annuals or herbaceous perennials which are unlikely to be detected unless field surveys take place at certain times of the year and following good rainfall.

Anomalies exist between the species detected *e.g.* the earlier survey (BA-03) detected a single *Acacia* species over a survey area of the entire Narran Warrambool Reserve while the later surveys (BA-06) which were limited to the properties of Barfield and Kurrajong (~6,886ha) detected five *Acacia* species. Similarly, the earlier survey detected two *Eucalyptus* species over an extensive survey area (despite having recorded four vegetation types (S5.1 [60]) while the later surveys of the properties of Barfield and Kurrajong detected four *Eucalyptus* species.

Neither study detected any threatened flora species; a current search of the NP&WS Atlas of NSW Wildlife Atlas database records and the generation of an EPBC Environmental Report reveals the potential (depending on the radius of search) for at least seven threatened [61] species (*Phyllanthus maderaspatensis, Goodenia macbarronii, Ipomoea diamantinensis, Lepidium monoplocoides, Desmodium campylocaulon, Swainsona murrayana* and *Capparis loranthifolia var. loranthifolia*) and *Maireana lanosa* (possibly now extinct), the first four of which are considered Endangered [62] (See Appendix 1 for known distributions). In other surveys in the area, Benson *et al.* (2006) note that Poplar Box communities may contain potential habitat for several threatened flora species not mentioned in the REF or the Biodiversity Assessment documents: *Acacia curranii, Goodenia occidentalis, Osteocarpum sclerocarpum* and *Sida rohlenae.* Documentation provided by NFRPC (2004), whose mapping both the REF-04 and BA-06 reports by Parsons Brinckerhoff use, note that their 'Poplar Box – Pine – Other' community provides habitat for *Cyperus conicus*; despite this, and that the Barfield and Kurrajong report (BA-06) states this species "*...is predicted to occur within Poplar Box, pine other vegetation community that occurs within the site",* the report asserts that there is no 'preferred habitat' for this species within their survey area and no assessment of the significance of impacts from the proposed opal mining activities is undertaken.

BA-03 (CSU 2003) for the *Narran Warrambool Reserve* mentions (at [S4.1.2 p.19]) historical records of ten species in the Walgett LGA or in the area covered by the Walgett RVMP. The REF further states, under the heading "Eight Part Test" in Appendix 4, that "*...six species of flora ... listed in the schedules of the NSW* Threatened Species Conservation Act 1995 *have a range that extends over the Proposal Site (tabled below).*" The table that follows lists ten plant species, one of which is not a threatened species: this makes it difficult to understand which threatened flora species are being referred to and, despite the statement that the range of some of these species "*...extends over the Proposal Site*" (presumably implying that at least some habitat for one or more of these species occurs within the study area), no Section 5a impact assessments [63] are undertaken, the potential for their occurrence is not further discussed and no reasons for this omission are given.

BA-06 considers seven (six as above and one additional species) species (*Cyperus conicus, Desmodium campylocaulon, Goodenia macbarronii, Ipomoea diamantinensis, Lepidium monoplocoides, Phyllanthus maderaspatensis* and *Swainsona murrayana*) but does not consider the potential for *Capparis loranthifolia var. loranthifolia.* The report states (Parsons Brinckerhoff 2006, p.35) "*Two Threatened species of plant have been recorded within*

60 Thompson above n 4(i), 3.

61 Listed on the schedules of the *Environment Protection and Biodiversity Conservation Act 1999* and *Threatened Species Conservation Act 1995.*

62 During Mitchell's exploration of the Narran River in 1846 a number of new plant species were described (Mitchell 1848) including: … *Kochia lanosa* Lindley (now *Maireana lanosa* (Lindley) in *'McGann, T. D., Kingswood, R. and Bell, D.* 2001. *Vegetation of Narran Lake Nature Reserve, North Western Plains, New South Wales. Cunninghamia* Vol. 7(1)'.

63 The test of significance in relation to threatened species, populations or ecological communities is contained in Section 5A of the EP&A Act.

the locality (Figure 5.2)"; as Figure 5.2 is missing from both versions of the report as provided, it is impossible to ascertain what these species may be. By contrast, Appendix F ('Threatened plants recorded within the locality') lists seven threatened flora species, none of which was detected during field surveys, with one species (*Goodenia macbarronii*) selected for impact assessment; however, despite noting potential habitat within the most widespread vegetation community on the site (the 'Poplar Box – Pine – Other' woodland of NFRPC [2004]), no impact assessment was conducted for *Cyperus conicus*. In addition, this report makes no mention of *Capparis loranthifolia* var. *loranthifolia,* a species known to occur [64] with Poplar Box, Silver-leaved Ironbark, Wilga, Mulga, Umbrella Wattle, Brigalow, Budda, Whitewood and Spinifex (all species recorded in the survey). For *Goodenia macbarronii,* under the table column 'Impact assessments undertaken' (Appendix F), the report states "*No. Species unlikely to occur within site and areas providing marginal habitat for this species are likely to be restricted to banks of sandy creeks, seasonally damp sites such as box swamps and depressions as a result of recent excavations and these areas would be avoided*". Unless extensive targeted surveys for the species were undertaken, it is not clear how the statement that the species is unlikely to occur in a range of potential habitats in various communities within the area surveyed can be justified.

Of the potential habitats provided within the site, BA-06 states habitat is not present or "unlikely" to occur for all of the threatened species considered, but fails to adequately discuss or describe the criteria used to make these conclusions. This is particularly relevant given that a search of the NP&WS Atlas of NSW Wildlife Atlas database records revealed the presence of four flora species. Furthermore, both *Lepidium monoplocoides* and *Goodenia macbarronii* were detected during field surveys in Community 1 (Mixed Low Woodlands) of McGann *et al.* (2001) in the adjacent Narran Lakes Nature Reserve: BA-06, however, notes potential habitat for only one of these species (*Goodenia macbarronii*), and that in "*seasonally damp and swamp sites such as dams and box swamps.*" Despite the established occurrence of this species in a vegetation community similar to the "Poplar Box – Pine – Other" described by Parsons Brinckerhoff (2006), the Barfield and Kurrajong report states that "*Furthermore, this species is not predicted to occur within the vegetation communities occurring within the site.*"

Profiles of the threatened species detected on the NP&WS Atlas of NSW Wildlife Atlas database records which are known to occur in the area are provided below in Appendix 3 (source: Threatened Species Profiles DECC).

4.2.1.2 Ecological Communities

REF-04 (S6.3, p70) states that '*The nature of opal mining within the Narran-Warrambool Reserve is such that specific areas of mature Bimble Box will be affected by opal mining. The specific location of the next opal mining area is usually not known until mining has already begun. For this reason a cautious approach to the impacts of opal mining on flora and fauna is recommended.*' In addition, the author states (S6.3, p70) that '*Species chosen for the eight-part tests have known associations with the vegetation found in the region, including Bimble Box and White Cypress Pine Woodlands. Other threatened species have a range that extends over the study area but it is unlikely that these species will be affected by the impacts of opal mining. The assessment indicated that, on the knowledge gathered in this survey and previous surveys, continued opal mining in its current form is likely to result in a significant impact on the Five-clawed Worm-skink, Bush Thick-knee, Hooded Robin, Black-chinned Honeyeater, Barking Owl and Koala and therefore further investigation is recommended to the level of a Species Impact Statement to assist in developing a biodiversity plan for OPA 4.*' Benson *et al.* (2006) notes the poor representation of Poplar Box woodlands (*e.g.* Poplar Box – Coolabah floodplain woodland, Poplar Box – White Cypress Pine shrubby woodland on red sandy loam soils) in protected reserves, with less than 1% of the former community and less than 2% of the latter protected; similarly, NFRPC (2004) note that '*Older poplar box trees have many hollows... Large old pine trees may be important for particular species but are now very rare in the landscape... As with other elevated*

64 DECC Species profile at: http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/profile.aspx?id=10144

communities poplar box/ pine/ other may function as a valuable flood refuge, especially at the boundary with low lying areas."

As a result of field surveys in a survey area estimated to be in the order of 500km2 (S2.2, p.9), BA-03 identifies (and gives short, basic descriptions of) only four vegetation communities. BA-06 describes seven vegetation types within the properties of Barfield and Kurrajong (6,886ha). No endangered ecological communities were detected during field surveys for either of these studies: although some general discussion of the potential impacts of opal mining activities on ecological communities is provided (*e.g.* REF-03, sections 4.1.4 and 5.1), no detailed description of the occurrence of potential EECs is given nor are any vegetation maps supplied. REF-06 provides limited notes on the potential for the occurrence of several EECs; however, given insufficient information in descriptions of vegetation communities, the occurrence of several plant species within the site which are characteristic of one or more EECs (according to the Final Determinations provided by the NSW Scientific Committee) and the reliance on mapping provided by NFRPC (2004) (whose limitations its authors clearly state), the basis for the unequivocal statements that no EECs occur within the site is not apparent; similarly, there is no discussion (or even acknowledgement) of the potential for the impacts of opal mining within the study area to affect EECs in adjacent areas (*e.g.* within Narran Lake Nature Reserve).

Ecological Communities of Conservation Significance – Review of Previous Studies, Final Determinations and Database Searches

McGann *et al.* (2001) – Vegetation of Narran Lakes nature Reserve, North Western Plains, NSW (*Cunninghamia* 7(1): 43-63)

Previous studies of the Narran Lake Nature Reserve (McGann *et al.* [2001]) [65] detected seven vegetation types; these are: 1) Mixed Low Woodlands, 2) Mulga Low Woodlands, 3) Triodia Hummock Grasslands, 4) Chenopod Low Open Shrublands, 5) Ephemeral Herbfields, 6) Riparian Open Forests, and 7) Lignum Shrubby Thickets.

According to this paper, the NSW NPWS is responsible for the management of the Narran Lake Nature Reserve (5538ha) and an additional area of land to the south-east of the Reserve itself, comprising the property formerly known as "Leumeah", with a total area of 3547ha. Both McGann *et al.* (2001) and the map accompanying the Narran Lake Nature Reserve Fire Management Strategy (NPWS 2004) show that this additional area extends east from the south-eastern boundary of the Reserve and its eastern boundaries are directly adjacent to the southern boundary of "Kurrajong" and to the south-eastern section of "Barfield". The vegetation communities classified and mapped in this paper are therefore likely to be directly comparable with those on Kurrajong and Barfield, the subject properties described in BA-06.

While no vegetation communities described in this paper are listed as 'Endangered' (TSC Act 1995) or 'Threatened' (EPBC Act 1999), Community 3 (Triodia Hummock Grasslands and Low Woodlands) is noted for containing habitat for restricted species (*Actinotus paddisonii*), while the occurrence of Community 2 (Mulga Low Woodlands) is thought to be significant as it is '*beyond the predicted eastern limit of its occurrence*'. Both *Lepidium monoplocoides* and *Goodenia macbarronii* were detected during field surveys in their Community 1 (Mixed Low Woodlands).

Benson *et al.* (2006) – New South Wales Vegetation Classification and Assessment: Part 1 Plant Communities of the NSW Western Plains (*Cunninghamia* 9(3): 329-381)

65 McGann above n 9, 3.

Benson *et al.* (2006) describe several plant communities in the Western Plains which appear to share both floristic and structural affinities with those described in the BA-03; REF-04 and BA-06. These include:

- Poplar Box – Coolabah floodplain woodland on light clay soils mainly in the Darling Riverine Plain Bioregion: this community is described as mapped for the Walgett area by NFRPC (2004) and may be a constituent of the 'Poplar Box – Pine – Other' or 'Box Swamp' communities of BA-06. Threatened species noted in the description are *Capapris lornathifolia* var. *loranthifolia, Lepidium monoplocoides, Osteocarpum scleropterum, Phyllanthus maderaspatensis* and *Sida rohlenae;*
- Poplar Box – White Cypress Pine shrubby woodland on red sandy loam soils mainly on stagnant alluvial plains: this community is described as '*similar to or equivalent to*' the 'Poplar Box – Pine – Other' of NFRPC (2004), and is considered 'Near Threatened' due to over-grazing and its lack of representation (<1%) in protected areas;
- Poplar Box grassy/ shrubby woodland on alluvial clay-loam soils mainly in the temperate (hot summer) climate zone of central NSW (wheatbelt):
- Buck Spinifex hummock grassland – Silver-leaved Ironbark open woodland on deep sand: described as being mapped by NFPRC (2004) '*between Walgett and Bourke*'. The community is noted as being restricted in its distribution, from near Enngonia to Cumborah, indicating that it is at the limit of its distribution in the area surveyed by Parsons Brinckerhoff (BA-06). Threatened species described are *Acacia cowleana* and *Polygala linariifolia;* described as having a shrub layer '*containing a rich assemblage of species*', the description includes 25 shrub and 18 groundcover species alone. Probably equivalent or similar to Spinifex (Silver-leaf Ironbark, Poplar Box Woodland) of Parsons Brinckerhoff (BA-06);
- Sandplain Mulga tall open shrubland of the semi-arid and arid climate zones: described as part of the Mulga (MUL) unit of NFRPC (2004). Threatened species noted are *Acacia carneorum, Acacia notabilis, Atriplex sturtii, Calotis moorei, Crotalaria cunninghamii, Goodenia macbarronii, Goodenia occidentalis, Ipomoea polymorpha, Polycarpaea spirostylis* subsp. *glabra, Polygala linariifolia* and *Swaisona viridis*;
- Canegrass swamp of drainage depressions, lakes and pans of the inland plains: described as widespread throughout western NSW on clay pans on heavy non-cracking clay soils; threatened species noted are *Aponogeton queenslandicus, Atriplex infrequens, Atriplex sturtii, Dentella minutissima, Dysphania platycarpa, Eleocharis obicis, Pimelea elongate* and *Solanum karsense.*

Thoms *et al.* (2006) - Narran Lakes Scoping Study (Co-operative Research Centre for Freshwater Ecology)

This study reviews the existing data and reports on the hydrological and ecological factors relevant to the Lower Balonne Floodplain and the Narran Lakes system in particular. A general overview of the Lower Balonne hydrological network is provided, with emphasis on the likely effects of large-scale water resource extraction on the ecology of Narran Lakes.

Vegetation descriptions and flora species lists rely on Hunter *et al.* (1999) whose study was later submitted (under McGann *et al.* (2001)) to *Cunninghamia* (as summarised above). With respect to vegetation, the report notes '*As stated by Young* et al. ... "Flooding is the single most important natural influence on floodplain vegetation, and determines species distribution, growth of individual trees, reproduction, regeneration and population age structure..." and '*Twenty five species of floodplain vegetation of the Walgett area have been listed as having traditional significance as food, medicinal properties, important in ceremonies, for shelter, as implements and one species, the river red gum is of mythological importance*'. In conclusion, the study states '*We can identify four major changes to the Narran River and its floodplain ecosystem related to human activity since European settlement within the Condamine-Balonne catchment:*

- ***Altered hydrology in Narran River due to water abstraction*** *in the Condamine-Balonne catchment. There are a range of types of water resource developments in this catchment. These include both instream and offstream storages, direct abstraction from the river and the* ***harvesting of overland flows****. ...*
- *Construction of off-stream storages and levee banks with the resulting loss of floodplain area. ...*
- ***Clearing of native vegetation*** *will result in* ***greater rates of erosion, altered sediment types and increased sediment delivery to the river and wetlands****. Potentially associated with this increased sedimentation will be increased deposition of pesticides,* ***increased salinisation****, and* ***increased susceptibility to invasion by exotic plants****.*
- *Introduction and maintenance of grazing stock and feral animals (goats, rabbits etc.). These animals reduce the rate of recovery of floodplain vegetation and exacerbate the effects caused by land clearing.*" (**emphasis** added).

Endangered Ecological Communities known to occur within the Darling Riverine Plains Bioregion (NSW Scientific Committee Determinations [66])

Coolibah-Black Box woodland of the northern riverine plains in the Darling Riverine Plains and Brigalow Belt South bioregions

BA-03 notes that vegetation communities dominated by Poplar Box (referred to as 'Bimble Box') are those most likely to be affected by opal prospecting and mining activities. The document then goes on to give a brief description of a Coolibah (*Eucalyptus coolabah*) woodland and a Black Box-River Red Gum woodland; however, due to the sparing descriptions of these communities, it is not clear where they occur, and consequently to what extent they may be affected by opal mining activities. This lack of clarity regarding the distribution and possible extent of impacts is further compounded by the absence of any vegetation mapping in the report, or any reference to mapping carried out by other studies; the importance of this lack of information is further amplified by the listing of Coolibah-Black Box woodland as an Endangered Ecological Community under the Schedules to the TSC Act 1995. Sections 4.4 and 5.1 discuss the conservation status of vegetation in the study area and the potential effects of opal mining, but these focus entirely on Poplar Box vegetation types. Nevertheless, section 5.1 of the report states that, at the time the report was written, the NSW Scientific Committee had issued a Preliminary Determination to list Coolibah-Black Box woodland as an EEC, and further notes that the four main vegetation types described in the REF "*have poorly defined boundaries and often there is a considerable transition zone between vegetation communities*". Given this and the statement that "*Although tree removal, opal mining and no rehabilitation within one fifty metre by fifty metre mineral claim is not a serious issue the cumulative effect of many mineral claims under the same treatment is... The cumulative affect* [sic] *of intensive mining in these areas is likely to have a significant impact upon both flora and fauna...*" it is clear that further investigation of the classification and extent of vegetation communities within all OPAs (and particularly OPA4) is required; this is reinforced by the need for a 'precautionary approach' to underpin ecological impact assessment and the obligation (s.111 EP&A Act 1979) to '*examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment*'.

BA-06 describes seven vegetation communities, based extensively on existing regional vegetation classification and mapping provided by NFRPC (2004). As noted above, the NRFPC mapping has a native resolution of 1:100 000; this is likely to be too coarse to be reliable at the scale required for the purposes of the Barfield and Kurrajong report, despite claims in this report that vegetation communities were 'ground truthed'. It is possible, if not likely, that further field survey would enable finer resolution of vegetation communities within the study area, particularly given that many of the species considered diagnostic of the Coolibah-Black Box woodland EEC were recorded within the study area.

66 DECC above at n 62, 16.

Myall Woodland in the Darling Riverine Plains, Brigalow Belt South, Cobar Peneplain, Murray-Darling Depression, Riverina and NSW South western Slopes bioregions

As noted for the Coolibah-Black Box woodland EEC above, it is not possible to ascertain whether or not this EEC occurs within OPAs 1-3 or OPA 4, given the basic descriptions of vegetation communities, the low number of vegetation communities described and the lack of any vegetation mapping for the study area. Given the large area that is covered by the Narran-Warrambool Reserve, it seems likely that at least some areas of this EEC occur within it. Benson *et al.* (2006) do not show its occurrence within either Walgett or Brewarrina LGAs; however, they note that this community is often not detected by satellite imagery, as is used for the basis of the classification and mapping by NFRPC (2004). Mapping provided by NFRPC (2004) does not show any occurrences of any vegetation communities dominated by Myall on either the Narran or Cumborah 1:100 000 map sheets.

BA-06 states that the '*species assemblage* [was] *not recorded*', although *Acacia pendula* is listed in the species list for the site (Appendix D); given the sparse descriptions of the vegetation communities provided, it is not possible to ascertain which community(s) this species occurs in.

Brigalow-Gidgee woodland/shrubland in the Mulga Lands and Darling Riverine Plains Bioregions

Despite covering the entire Narran-Warrambool Reserve, BA-03 did not record either Brigalow (*Acacia harpophylla*) or Gidgee (*Acacia cambagei*), two relatively common species in the Western Slopes and Plains botanic regions. NFRPC (2004) note the occurrence of '*small isolated clumps*' of Brigalow in the western division of Walgett Shire LGA and although it states that Brigalow communities occupy only 18ha, the species is '*the dominant tree'*. Similarly, NFRPC (2004) note only small areas of Gidgee in the same area, stating also that it occurs with Poplar Box *Eucalyptus populnea,* and is potential habitat for the threatened species *Desmodium campylocaulon, Ipomoea diamantinensis* and *Phyllanthus maderaspatensis.* Occurrences of Gidgee communities on the Cumborah and Narran 1:100 000 map sheets are described as '*less than the minimum-mapping unit of 50ha. Some small areas of gidgee may not have been mapped*', but note also that the 18ha total area of Brigalow mapped is less than the 50ha minimum unit, and areas of this community may also have missed.

BA-06 states that the Brigalow-Gidgee EEC does not occur within their study area and that '*species assemblage* [was] *not recorded*', although *Acacia cambagei* was recorded from the site (Appendix D); as noted above, it is not possible to ascertain in which community this species was recorded. Given that the vegetation mapping in this report is largely based on that provided by NFRPC (2004), and given the stated limitations of that mapping (described above), it is possible, if not likely, that further field surveys would enable finer resolution of vegetation communities within the study area, particularly given that some species considered diagnostic of the Brigalow-Gidgee EEC were recorded within the study area.

Fuzzy Box Woodland on alluvial soils of the South Western Slopes, Darling Riverine Plains and Brigalow Belt South Bioregions

While the Final Determination for this EEC notes its occurrence in '*parts of the Darling Riverine Plains Bioregion*', it has not been recorded in the Walgett or Brewarrina LGAs by Benson *et al.* (2006), nor has it been mapped within the Narran (8338) or Cumborah (8438) 1:100 000 vegetation map sheets (NFRPC 2004).

Brigalow within the Brigalow Belt South, Nandewar and Darling Riverine Plains bioregions and *Carbeen open forest community in the Darling Riverine Plains and Brigalow Belt South bioregions*

Both of these EECs were listed on the Schedules to the TSC Act 1995 before field surveys were undertaken by CSU and Parsons Brinckerhoff; however, neither the BA-03 nor BA-06 mention or consider the potential for the presence of either of these EECs, even though several tree, shrub and groundcover species are mentioned in both reports which are named in the scientific committee determinations for one or both of these EECs. Given the sparing vegetation community descriptions

provided in both reports, the lack of any vegetation mapping in the BA-03 and the constraints of the NFRPC (2004) vegetation classification and mapping used as the basis of the vegetation mapping by BA-06, further field surveys may be required to verify the presence or otherwise of these EECs and the extent of any impacts arising from opal mining activities.

Artesian springs ecological community
While the Final Determination for this EEC notes its occurrence in '*the Darling Riverine Plains Bioregion*', it has not been recorded in the Walgett or Brewarrina LGAs by Benson *et al.* (2006), nor has it been mapped within the Narran (8338) or Cumborah (8438) 1:100 000 vegetation map sheets (NFRPC 2004).

The *Old man saltbush shrubland in western NSW* remains the subject of a Preliminary Determination for listing as an EEC (first listed in March 2006). This is characteristically a shrubland of varying height and cover, often with scattered tree cover including Black Box *Eucalyptus largiflorens* and Coolibah *Eucalyptus coolabah.* Characteristic species are Old Man Saltbush *Atriplex nummularia* with a range of Chenopodiaceae taxa including *Atriplex* spp., *Einadia* spp. and *Sclerolaena* spp., many of which are included in the Barfield and Kurrajong report species list (Appendix D: BA-06). Several patches of Chenopod shrubland are mapped on the Cumborah 1:100 000 map sheet; given the limitations of the mapping scale and the 50ha minimum patch size cut-off, it is possible that other patches too small to map occur. Potential habitat for this EEC is also likely to occur within Narran Lakes Nature Reserve.

Groundwater Dependent Ecosystems (GDE)
The *Land and Water Resources Research and Development Corporation* [67] (p.58) note the significance of vegetation within and surrounding Narran Lake, stating that within the Central Lowlands and South Australian Ranges '*There are few (naturally) permanent lakes. Narran Lake, near Brewarrina, is the terminal drainage basin for the Narran River (a distributary of the Balonne River); it supports canegrass (Eragrostis australasica) and Phragmites grasslands, and Lignum shrublands. The role of groundwater in maintaining this system is not known.*' This report further states (p.25) that '*It has only been in the last two decades that Australian science has begun to appreciate the extent and degree of dependence of non-wetland vegetation on groundwater... We have a relatively poor understanding of how adaptive vegetation is with respect to changing the depth, quality and regime of groundwater.*'

Other than general references to wetlands, there is very little discussion within either BA-03, BA-06 or REF-04 of the occurrence of GDEs, or the potential impacts of opal mining and associated activities (such as use of bore water, diversion of surface flows or wet puddling operations) on vegetation communities which are dependent on groundwater flow regimes.

One further (and possibly fundamental) flaw exists in the basis that underlies the impact assessments in BA-06. Almost all of the Assessments of Significance base the discussion and conclusions of impacts on threatened biota on the assumption of 'a moderate level of mining activity'. There are no descriptions of what a 'moderate level of mining' is, either in the BA-03, BA-06 or REF-04, nor are any references given to other documents which might describe this. Furthermore, even in the absence of a description of the effects of a 'moderate level' of mining, no justifications are made or reasons given for the assumption that this is the most likely scenario: since not even prospectors know how much opal will be found in the area, what is the basis for the assertion that a 'moderate level' of mining will occur in the sites under investigation? Given this lack of information, it is not clear how the authors of BA-06 have fulfilled their obligation to '*examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity*' as required by s.111 of the EP&A Act.

Fauna

67 Thompson above n4(i).

An EPBC Environmental Report and a search of the DECC Atlas of NSW Wildlife [68] revealed a range of threatened species which are known from the area (see Table 2, Appendix 2 below).

OPA 4 is an area of land measuring around 1600km2, within which only one fauna survey site was established during the field studies associated with BA-03. This survey site comprised a small number of bird surveys lasting 20 minutes ('Seven bird surveys of at least twenty minutes each were undertaken at mined, unmined and rehabilitated sites… Five surveys were undertaken in rehabilitated mining areas with one in an active mining area and one in the unmined area of OPA 4); no specific surveys for flying- or non-flying mammals, frogs or reptiles were undertaken. A recommendation outlined in Table 7.1 of REF-04 stated that '*Further investigations should be undertaken within OPA 4 to assist with biodiversity and conservation planning within the region. These investigations should be undertaken following consultation with the New South Wales Department of Environment and Conservation and the Commonwealth Department of Environment and Heritage and should aim develop a planned opening of OPA 4 such that there is no significant impact on threatened species or items of cultural significance'*. Consequently, the Department of Primary Industries commissioned Parsons Brinckerhoff to investigate the biodiversity values of two properties (Barfield and Kurrajong – total area 6886ha) situated in the central north-eastern precinct of OPA 4 between Cumborah and Narran Lakes. It is presumed that these two areas have been identified as the first stage for the release of opal mining within OPA 4, as they provide an inadequate representation on an area measuring some 1600 km2. The recommendation outlined above suggests that a broader scale survey within OPA 4 was required to assist with biodiversity and conservation planning. In the reports reviewed, the area of OPA 4 beyond the Barfield and Kurrajong properties has only been sampled to assess its fauna values at a single location where the sampling regime outlined above was undertaken.

Aside from the restricted areas surveyed within OPA 4, BA-06 identifies the area as containing seven vegetation communities including Poplar Box, Spinifex, Grassland, Canegrass Swamps, Mulga Shrubland, Callitris Woodland and Box Swamps (Parsons Brinckerhoff 2006). These have been categorised by Parsons Brinckerhoff into five broad fauna habitats: Woodland dominated principally by eucalypts, Callitris Woodland, Mulga Shrubland, Canegrass and Aquatic habitats including lakes and dams.

BA-06 suggests that OPA 4 is principally used by pastoralists for livestock grazing pursuits including sheep, goats and cattle. Granting permission to prospect for opal in OPA 4 is proposed within areas of 0.25 ha. Impacts on fauna include the removal of vegetation including ground covers and mid stratum vegetation, and in some cases trees containing hollows may require removal in order to facilitate infrastructure associated with the mining process. Woody ground debris and standing dead timber is also likely to be removed by prospectors as a source of heating and cooking fuel, and in some cases where underground mining permits, timber such as White Cypress Pine is likely to be sourced locally (*i.e.* within OPA 4). It is reasonable to suggest that soil compaction will occur in these areas and there is potential for small-medium scale chemical and fuel spills during the fueling and maintenance of plant and machinery. Whilst the claim areas are small in size (*i.e.* 0.25 ha), those areas which produce economically viable quantities of opal are likely to be subject to multiple claims, thus creating cumulative impacts and/ or impacts at a broader scale. Additionally, the ecological footprint associated with an individual claim is likely to be greater than the nominal 0.25ha claim area, for reasons outlined above, and may be exacerbated by additional impacts (such as access tracks and centralized mullock dumps) documented as being part of the mining process. Note that impacts arising from increases of vehicular traffic (*i.e.* prospectors, road maintenance), threat of wildfire, domestic pets and activity levels of specific predators that exploit edge associated habitats (*i.e.* fox) have not been either adequately addressed or mentioned in the document. The potential scale of the impacts arising from opal mining

68 OPA4 search area within the Narran [8338]; Cumborah [8438]; Brewarrina [8238]; Goodooga [8339]; Lightning Ridge [8439]; Weilmoringle [8239]; Gongolgon [8237]; Geera [8337]; and Carinda [8437] 1:100 000 map sheets.

cannot be gauged from the documents supplied, other than from generalized statements, including that impacts will occur at a broader scale, or will occur in accordance with a set of draft conditions (March 2006); these draft conditions identify minimum retention values for ground cover, maximum timber sizes for removal, a 'no burn' policy and no taking of native flora.

BA-06 (Section 6.0, p. 42) states that the potential impacts on biodiversity values are assessed assuming 'moderate' levels of mining activity. The qualifier 'moderate' is not quantified in the report, and there is consequently some doubt as to the scale of potential impacts assumed in the assessments of significance (s.5a EP&A Act 1979) and in addressing effects on matters of national environmental significance (*i.e.* those species listed under the Commonwealth EPBC Act 1999). Moreover, the opportunity to both quantify and qualify the impacts arising from mining activities within OPA 4 appears to have been overlooked, and should have been tabled as a key recommendation in the BA-03 and BA-06. The location of OPA 4 adjoining existing opal mining areas (OPAs 1-3) and the analogous habitats present would have improved the accuracy and relevance of any such comparison and assessment. The resulting difference in biodiversity or quantitative habitat data (if present) would have provided a more meaningful indication as to the likely changes in habitat diversity, structure, landscape values and impacts on individual taxa than that provided in both reports. Adoption of such a recommendation (if put forward by the consultant and subsequently adopted by DPI) would have been a step in exercising the obligation '*to examine and take into account to the fullest extent possible all matters affecting or likely to affect the environment by reason of that activity*', as defined under Section 111 of the EP&A Act 1979. Justification of this approach using a standard flora and fauna survey of 6 days per area would have culminated in a more robust and ecologically meaningful data set than that provided in the two reports (BA-03 AND BA-06), and could have been conducted within a similar time frame; whilst not exhaustive, this approach would have provided a more sound platform on which to base the range and extent of likely impacts, would have provided better information for significance assessments (for both state and commonwealth legislation), and would have more accurately described and mapped key habitats worthy of preservation or protection (*i.e.* mining exclusion zones).

Under Part 5 of the EP&A Act 1979, s.111 of the EP&A Act 1979 requires public authorities to consider '*to the fullest extent possible*' the potential environmental effects of their decisions where development consent is not required. On those grounds, it would appear that although the proponent has engaged a consultancy to prepare an REF (along with a subsequent further report on OPA 4), BA-06 and earlier documents do not fully account for the potential impacts arising from opal mining to be conducted within OPA 4. This is based on the limited duration of field surveys which were also concentrated in a relatively small area, the absence of comparison of the ecological values in existing opal mining areas with those of the proposed OPA 4, and the failure to consider all species which have a reasonable likelihood of occurring in the study area. There are also examples where vulnerable species (Schedule 2 of the TSC Act) have been omitted from the impact or significance assessment tests; for example, the Little-pied Bat (*Chalinolobus picatus*) was recorded during surveys, is known to utilise tree hollows in box woodlands, yet impacts on this species were not assessed under the relevant statutory process.

Additionally, the field surveys undertaken for BA-06 occasionally appear insufficient, even to address one of the recommendations of the REF ('*further detailed biodiversity surveys in those areas considered to have environmental sensitivities*'). Although '*detailed*' is a subjective term, it would be reasonable to suggest that field surveys should target fauna of conservation significance (listed under commonwealth and/ or state legislation), as the findings of such surveys facilitate more soundly-based impact assessments. A review of both the BA-03 and the BA-06 suggests that determining the significance of the area was inherently flawed, as both are heavily reliant on opportunistic sightings and habitat assessments. Despite two field survey sessions, trapping and survey techniques (which are ingrained methods among ecologists surveying woodlands and semi arid ecosystems) were not adopted, nor do established field survey

guidelines (*e.g.* those prepared by DLWC and DEC) appear to have been consulted. Given the combination of a poorly surveyed area such as OPA 4 and a suite of species that have cryptic habits, survey techniques should have focused on those most appropriate to enable their detection (*e.g.* pitfall trapping for the Five-clawed Worm Skink (*Anomalopus mackayi*) in box woodlands and grassland communities on heavier soils). With respect to EPBC listed species, the field methods employed were insufficient to adequately survey for the Greater Long-eared Bat (*Nyctophilus timoriensis*): other than casually identifying to genus level, the call of this species cannot be reliably identified using Anabat Detectors [69]; however, harp trapping of the survey area would have provided a more robust approach.

While field surveys cannot rule out a species from occurring within a site, they can identify with a greater degree of accuracy the ecological significance of the area, particularly in the event that considerable numbers of individuals were recorded, or evidence of breeding status had been observed (*i.e.* surveys were undertaken at a time when young bats could have been captured or females in late stages of lactation may have been captured). Where such targeted techniques are not used, reporting and impact assessment should be more reliant on the precautionary principle, particularly regarding those species which are likely to have sedentary habits in localised areas; where it is not possible to assess potential impacts with some confidence, the application of the precautionary principle would likely have resulted in an EIS being recommended. It also needs to be stated that in many cases species are listed on schedules of either the TSC Act or EPBC Act because there is insufficient data relating to their distribution and habitat requirements. Therefore, using database searches and broad habitat assessments as the basis for qualifying impacts on threatened taxa is not likely to be accurate or sufficient, especially in poorly studied areas.

A review of BA-03 AND BA-06 shows that the results obtained during both field surveys (see summary in Table 2 below) reflect the techniques employed, with poor and possibly substantially underestimated species richness levels in all vertebrate groups; consequently, species of legislative significance are somewhat unlikely to have been detected [70]. For example, it would be expected that pitfall trapping be undertaken in order to sample for a range of small ground dwelling mammals (*e.g.* Strip-faced Dunnart), as well as cryptic species and difficult to catch taxa such as reptiles (*i.e. Ctenotus pantherinus ocellifer*).

Table 2. Summary of field survey results obtained from BA-03 and BA-06

Surveyor Group	Survey Time	Duration (days)	Birds	Mammals	Reptiles	Frogs	Threatened Species
CSU – Johnston Centre	12-15th August	4	43	5	1	0	3
PB - Sydney	30 Jan-3rd Feb	5	56	19	3	0	4 [71]

It is also not uncommon in seldom or little surveyed areas such as OPA 4 that species of uncertain taxonomic status (*i.e.* new species), or species beyond their reported distributional limit are detected. In some cases complete taxon groups (such as frog fauna) have gone unrecorded in BA-03, REF-04 and BA-06, despite heavy rainfall occurring during the BA-03 field surveys (evident in a number of Plates presented within the BA-03 report). Whilst it is acknowledged that no frog species listed as

69 Two other species of *Nyctophilus* (*N. gouldi* and *N. geoffroyi*) are known to occur in the Lightning Ridge area

70 Threatened taxa by virtue of their rarity would be expected to occur more frequently in the later stages of species accumulation curves.

71 Little-pied Bat (*Chalinolobus picatus*) a vulnerable species listed on schedules of the TSC Act (1995)

conservation significance at the time were considered reasonably likely to occur in the study area, impacts on potential habitats still require consideration under the EP&A Act 1979. With respect to threatened taxa recorded during the surveys, microchiropteran bat fauna are likely to represent the only species group with cryptic habits (other species are considered relatively conspicuous); for this group, the amount of Anabat detection as stated appears adequate. In summary, given the above field survey effort results, the reports present species richness values that are likely to be a considerable under-representation of the fauna assemblages likely to occur within OPA 4.

The prevailing dry conditions at the time of 2006 survey are likely to have reduced the opportunity for detecting many of the frog fauna known or considered likely to occur in the Cumborah area. However, dry survey conditions alone would not fully explain the poor representation of other faunal groups, and the subsequent interpretations of impact arising from mining. This is substantiated by the presence of multiple fauna habitats and vegetation communities within the study area, which is itself adjacent to Narran Lakes (a Ramsar wetland of international significance). Dry conditions also provide other opportunities to field surveyors as a consequence of highly mobile species (typically birds) move from further inland areas, resulting in a new suite of species potentially being detected. Of the cryptic fauna known or likely to occur within the surveyed area, only microchiropteran bat fauna appear to have been sampled in a more adequate manner via the use of Anabat detectors, however more suited techniques such as harp trapping and trip-lining would have provided a better indication as to the status of members of this group, particularly for species listed on schedules of either state or Commonwealth legislation (*i.e.* trip-lining for free-tail bats and harp trapping for Greater Long-eared Bat). This latter point has not been mentioned as part of the report, and it could be reasonably argued that a number of migratory and nomadic threatened bird species (*i.e.* Pied Honeyeater) have been overlooked. For other fauna groups, including small ground dwelling dasyurids such as the threatened Stripe-faced Dunnart, dry conditions can provide opportunity for increased detection as individual dunnarts move in search of resources [72]. Similarly, it could be expected that dry conditions would not normally reduce the likelihood of detecting many of the reptile species considered likely or known to occur within the Cumborah area; given the field survey timing and weather conditions, a greater number of nocturnal reptiles (such as small elapid snakes and geckos) should have been detected. In attempting to evaluate the actual level of survey effort for specific techniques, a number of inconsistencies between statements in the text and figures presented in Table 4-2 (BA-06) are evident. For example, text in the report (p.15) states that spotlighting was undertaken over 4 consecutive nights, however, Table 4.2 indicates 3 nights of spotlighting with one of these nights being a vehicle-based traverse. Furthermore, there is no indication of the duration (*i.e.* actual survey effort) of spotlighting sessions on each night.

The report identifies that the box swamp and Spinifex communities be subject to more detailed surveys. Given the descriptions of several fauna habitat types in the report (and the possible significance of the box woodlands with the potential for hollow-bearing tree resources), it is difficult to establish why further surveys are recommended for these areas alone.

Recommendations

Given the above it would seem appropriate that the determining authority strongly consider the need for an EIS; further field surveys are obviously warranted, and the resulting reports have not adequately addressed legislative matters, including (but not limited to) matters to be considered under the EP&A Act 1979. Further examination of the study area surrounding OPA 4 suggests that a number of species (outlined in Table 3, below) warrant further consideration, with potential impacts assessed under the relevant legislation (*i.e.* s.5a EP&A Act 1979 for taxa listed under the TSC Act 1995 and, where relevant, an assessment of significance under the EPBC Act 1999).

[72] Dasyurid fauna often display no maternal home range in semi arid and arid environments

Table 3. Threatened fauna outlined in the review as requiring an assessment of significance with respect to relevant legislation.

Species	Considered in the PB (2006)	Comment
Pink Cockatoo	Yes	Agree with PB comments
Brown Treecreeper	Yes	Agree with PB comments
Brolga	No	Well known to utilise canegrass, open grassland and box swamp associations in western NSW
Hooded Robin	Yes	Agree with PB comments
Black-chinned Honeyeater	Yes	Agree with PB comments
Superb Parrot	No	This species should have been considered given that it was previously recorded in the region during the REF. It is acknowledged that species is on edge of its winter dispersal range.
Grey-crowned babbler	Yes	Agree with PB comments
Diamond Firetail	Yes	Agree with PB comments
Greater Long eared Bat	Yes	Agree with PB comments
Yellow-bellied Sheath-tail Bat	Yes	Agree with PB comments
Inland Forest Bat	Yes	Agree with PB comments
Five clawed Worm Skink	No	Predicted to occur in area and known from nearby Goodooga area to the north. Inhabits variety of habitats including box woodlands and open grassland habitats.
Red-tailed Black Cockatoo	No	Known from the Cumborah area; given the extent, location and scale of impacts of the proposal, this species should have been assessed
Bush Stone Curlew	No	Potentially occurring in open woodland habitats with records in adjacent OPA areas.
Ctenotus pantherinus ocellifer	No	Species is closely associated with Spinifex communities and nearest record is from Goodooga area.

It would be reasonable to expect that a study of this nature would provide an assessment of exotic animal activity within the study area; however, other than providing a presence/absence status, no further information is provided. Given that a number of the exotic species identified are those listed in a number of Key Threatening Processes under the TSC Act 1995 (and in some cases the EPBC Act 1999), the level of assessment and consideration in the reporting could be viewed as insufficient.

BA-03

- Where surveys are undertaken at times of the year inappropriate for recording certain fauna, this may have a significant bearing on the impact assessment process for a particular project. Field surveys for the BA-03 were undertaken in just a few days in August 2003.
- Plate 1 of the BA-03 depicts an area subject to mining activities. Potential impacts on sedentary species with small home ranges from disturbance such as that depicted gives cause for concern that the likely actual impacts have not been adequately assessed.
- Statements within the BA-03 imply that an adequate level of survey effort was not undertaken; for example (section 3.2.2, p.16) '*Adverse weather conditions, including strong winds and heavy rain, during the survey period prevented the survey of bats and nocturnal mammals. No targeted surveys were conducted for mammals during the survey.*'

- If heavy rain and windy conditions occurred during the BA-03 survey, it is not clear why frog surveys were not undertaken. The report states (section 3.2.3 p.17): *'The cool conditions meant that reptile activity was low and the absence of permanent water in most areas limits the distribution of amphibians. Incidental sightings were recorded.'* It is widely accepted that rainfall in semi-arid and arid landscapes of eastern Australia provide a rare breeding opportunity for local frog fauna. Given the weather conditions (as stated), this appears to have been a missed opportunity to adequately survey for frog fauna in OPA 4.

BA-06

- The extent of removal of ground habitats is likely to have been underestimated in the BA-06. BA-03 states that '*Many owners of Mineral Claims establish temporary dwellings on or near their Mineral Claim. No electricity sources are provided at the sites and consequently much of the woody debris surrounding opal mining areas has been removed and used for firewood. This reduction and sometimes-complete absence of woody debris may displace resident fauna including reptiles and the endangered Bush Stone-curlew that rely on woody debris for habitat.* Given that previous surveys of adjacent areas have identified a range of threatened bird species such as the Bush Stone Curlew, Diamond Firetail, Grey-headed Babbler and Hooded Robin, the removal of ground habitat features may in many cases result in a gradual decline of populations, thus increasing their vulnerability to other cues including predation.
- The significant bird taxa are primarily species which are either predominantly ground foraging (Grey-crowned Babbler, Diamond Firetail) or significantly so (Brown Treecreeper, Hooded Robin, Pink Cockatoo). The suggested levels of disturbance to leaf and stick litter, decaying timber and standing trees through mining and processing, access, human habitation or clearance for mine props or fuel may have significant impacts, very little of which are either noted or described in detail. Grey-crowned Babblers in particular are affected by reductions in ground level invertebrates that accompany the removal of fallen timber and the concomitant process of substrate compaction and litter removal [73]. This perturbation and the prescription that a minimum of 25% of vegetation must remain undisturbed would appear to contradict the stated requirements for the maintenance of a healthy population outlined in BA-06 (pp.37-8). The survey methods employed were too spatially narrow to detect the status and stability of such populations over the area of OPA4, given the assumed healthy family territories (2-53 ha per tribe).
- BA-03 concluded that mining in OPA 1-4 was likely to result in a significant impact on a range of threatened species. The assessments indicated that, based on the knowledge gathered in their surveys, mining activities would significantly affect '… *the Five-clawed Worm-skink, Bush Thick-knee, Hooded Robin, Black-chinned Honeyeater, Barking Owl and Koala and therefore a Species Impact Statement (SIS) would be required.*' This conclusion differs markedly from the impact assessments and conclusions in the Parsons Brinckerhoff (2006) report prepared for OPA 4.
- The BA-03 states '*The retention of any mature hollow bearing trees in Bimble Box dominated ridges is of a high priority due to their current poor retention rates within a regional context. Currently, future development rates for Bimble Box communities in the western region of the Walgett RVMP are set at 5 percent (2041ha). This figure has been set to help prevent over development and loss of flora and fauna. Over development of Bimble Box/White Cypress Pine communities has occurred in the east of the RVMP and no future development is allowed here. Furthermore, because of this over development in the east, the conservation and retention of similar communities in the west is paramount if species that survive on this community are to persist. Bimble Box/White Cypress Pine dominated ridges exist in a disturbed state within OPA's 1 to 3 and are less disturbed and of high conservation value in OPA 4. The protection of this potential habitat is vital within*

73 Higgins P.J. and Peter J.M. 2002. *Handbook of Australian, New Zealand and Antarctic Birds. Vol. 6: Pardalotes to shrike-thrushes.* Oxford University Press, Melbourne.

OPA 4 and within the proposed gazettal area of Lumeah'. Conversely, both REF-04 and BA-06 fail to acknowledge the value of the box/cypress systems in the same way. Bimble Box (syn. Poplar Box) is known to produce a range of tree hollow sizes which are capable of supporting an array of vertebrate taxa including bats, possums, gliders, birds and arboreal snakes. Vegetation maps compiled by NFRPC (2004) indicate that Bimble (Poplar) Box communities are widespread throughout OPA 4, and the CSU REF suggests that these communities in the western section of Walgett are probably more intact than elsewhere. In many cases Bimble Box would form the dominant tree hollow resource, and consequently any stands of mature Bimble Box occurring within OPA 4 should be considered important to hollow dependant fauna.

- Undertaking habitat assessments is (at best) a coarse approach in attempting to ascertain the status of plant and animal taxa within a study area; furthermore, any such evaluation is made more difficult when field surveys and assessments are conducted during adverse seasonal conditions. While the extended drought conditions have been noted among the limitations of the survey, this cannot or should not be used as justification for the use of broad habitat-based assessments as a principal survey technique. This is partly supported in the earlier BA-03 assessment, which states that '*Because of the large size of the Narran Warrambool Reserve a blanket assessment of habitat for all threatened species is not a viable approach. Consequently a precautionary approach in the form of a significant impact must be adopted*'.
- A number of the recommendations outlined in section 6 of the BA-03 have not been adopted as part of the proposed activities in OPA 4 area.

REP-05

- Many of the comments made by local landholders support the perception that little or no rehabilitation takes place once mining or prospecting activities cease.
- Claim sites are often joined together, resulting in cumulative impacts. Extracts from the Reddan and Gibbons (2005) report (quoted in REP-05, p.21) clearly show the magnitude of impacts from cumulative claims. The impact in these areas to ground dwelling and sedentary fauna with small material home ranges is not well documented in BA-06, nor have the field surveys in most cases been adequate to substantiate the presence or otherwise of such threatened taxa. Adoption of the principles of ESD and the precautionary principle lend further weight to the suggestion that an EIS is warranted to consider the full scope and extent of impacts in greater detail.
- The Representations Report (p.26) suggests that '*...following the precautionary principle it is concluded that there could be significant clearing of habitat which may result in extinction of local populations.*' A conclusion of this nature would normally warrant either further assessment (an EIS or an SIS) or that the project is turned down given impacts of such significance.

Given the inadequacies of the field surveys and supporting documentation outlined above, an EIS is recommended.

5.0 ADEQUACY OF ENVIRONMENTAL IMPACT ASSESSMENT AND MITIGATIVE MEASURES

5.1 Environmental Impact Assessments

The *Threatened Species Conservation Act 1995* (TSC Act) has modified the *Environmental Planning & Assessment Act 1979* (EP&A Act) by including a requirement in Section 5A (s.5A) to determine "*whether there is likely to be a significant effect on threatened species, populations or ecological communities, or their habitats*". The seven factors of s.5A "*must be taken into account*", particularly in administering Sections s.78, s79,

s.111 and s.112 of the EP&A Act and consequently in determining whether a Species Impact Statement is required.

In turn, the *Environmental Planning and Assessment Regulation 2000* [74] requires consideration of a number of factors [75] in order to determine whether the activity is likely to have a significant impact on the environment [76]. A précis of how these considerations have been dealt with in the REF-04 and subsequent reports (BA-03 and BA-06), in light of legislative requirements [77] is provided below:

(a) any environmental impact on a community

Comment: The summary checklist (REF-04, Appendix A p.109) concludes that a significant impact is unlikely and refers the reader to Section 6.5 for discussion. Contrary to this, Section 6.5 deals with climate and air quality for current and prospective operations. In fact, part of the information is provided under Section 6.4 (Cultural Heritage) and 6.11 (Social and Economic Impacts), although little consideration is given to population (including cultural, industry, employment); social significance (including aesthetic, anthropological, archaeological, cultural, historic, scientific, recreational or special value to present or future generations); scenic attributes of the landscape; amenity (any changes as a result of dust, noise, pollution); access (barriers to access; traffic movement) or changes to the landscape for the purpose of bushfire management.

(b) any transformation of a locality

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74 *Environmental Planning and Assessment Regulation 2000* s.228.

75 *Environmental Planning and Assessment Regulation 2000* s.228

What factors must be taken into account concerning the impact of an activity on the environment?

(2) The factors referred to in subclause (1) (b) (ii) are as follows:

(a) any environmental impact on a community,

(b) any transformation of a locality,

(c) any environmental impact on the ecosystems of the locality,

(d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality,

(e) any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations,

(f) any impact on the habitat of protected fauna (within the meaning of the *National Parks and Wildlife Act 1974*,

(g) any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air,

(h) any long-term effects on the environment,

(i) any degradation of the quality of the environment,

(j) any risk to the safety of the environment,

(k) any reduction in the range of beneficial uses of the environment,

(l) any pollution of the environment,

(m) any environmental problems associated with the disposal of waste,

(n) any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply,

(o) any cumulative environmental effect with other existing or likely future activities.

(3) For the purposes of this clause, the Director-General may establish guidelines for the factors to be taken into account when consideration is being given to the likely impact of an activity on the environment, in relation to activities generally or in relation to any particular kind of activity.

(4) The Director-General may vary or revoke any guidelines in force under this clause.

76 which would require the preparation of an Environmental Impact Statement or a Species Impact Statement.

77 Division 3 of the EP & A Act 1979 addresses the circumstances where an EIS is required. Under Part 5 of the EP & A Act, and EIS will be required where an activity is likely to 'significantly affect the environment'. Interpretation of this matter may be found in '*Is an EIS Required? – Best Practice Guidelines for Part 5 of the Environmental Planning and Assessment Act 1979* (Department of Urban Affairs and Planning 1996) (DUAP guidelines).

Comment: The summary checklist (REF-04, Appendix A p.109) concludes that a significant impact is unlikely and refers the reader to Section 6 for discussion. Contrary to this, Section 6 deals with a wide range of factors under various sub-sections. Some consideration is given to the potential transformation of the locality, including section 6.2 where the highly dispersible nature (and hence high erodibility) of mullock is discussed, hydrology, groundwater, flora and fauna impacts. The section which discusses current mining impacts states that '*Other threatened species have a range that extends over the study area but it is unlikely that these species will be affected by the impacts of opal mining. The assessment indicated that, on the knowledge gathered in this survey and previous surveys, continued opal mining in its current form is likely to result in a significant impact on the Five-clawed Worm-skink, Bush Thick-knee, Hooded Robin, Black-chinned Honeyeater, Barking Owl and Koala and therefore further investigation is recommended to the level of a Species Impact Statement to assist in developing a biodiversity plan for OPA 4*' (p6-16). However, the summary table concludes no significant impact.

(c) any environmental impact on the ecosystems of the locality

Comment: The summary checklist (REF-04, Appendix A p.109) concludes that a significant impact is unlikely and refers the reader to Section 6.4 for discussion. Contrary to this, Section 6.4 deals with cultural heritage. In fact, the information is provided under Section 6.3, p 6-9.

In section 6.3 the REF describes parallels between current impacts in OPAs 1-3 and OPA 4: '*Similar impacts would be expected to occur within OPA 4 as the soils and vegetation are of the same type. Impacts to the sensitive Narran Lakes catchment should be avoided and a proposed three kilometre buffer around the lake is recommended to prevent sediment mobilised by mining activity from reaching the lake. Improved management of mining operations is recommended to avoid some of the impacts noted above and to reduce the intensity of other impacts. These measures are outlined below*'. The document fails to discuss exactly how '*...impacts to the sensitive Narran Lakes catchment should be avoided*' given that parts of OPA4 are within its catchment. Similarly, the report fails to give details of how a proposed 3km buffer around Narran Lake would safeguard against such impacts. It is difficult to ascertain why the recommendations do not also consider a buffer to the Ramsar listed Narran Lake Nature Reserve situated to the north-west of Narran Lake.

The REF (S6.3, p 70) states that '*Although tree removal, opal mining and limited rehabilitation within individual mineral claims has only localised impacts, the cumulative effect of many mineral claims under the same treatment is more significant. Currently, there are approximately six thousand mineral claims lodged with the Department of Mineral Resources with most lodged within a twenty square kilometre area. The cumulative affect* [sic] *of intensive mining in these areas is likely to have a significant impact upon both flora and fauna*.' However, again, the checklist provided (Appendix A of the same report) concludes that there will be no significant impact in relation to this factor.

Section 6.3 also states that '*Impacts on fauna with the current mining areas of OPAs 1 to 3 include the removal of native vegetation, compaction and erosion of soils and removal of woody debris. The greatest possible impact upon fauna results in areas of Bimble Box and White Cypress Pine where opal mining is concentrated. The removal of hollow bearing trees, woody debris and ground cover species results in the loss of habitat for threatened and non threatened fauna*.' Section 4.3.2 further notes that '*Eight part test were applied to the Five-clawed skink, Bush Thick-Knee, Pink Cockatoo, Red-tailed Black Cockatoo, Hooded Robin, Black-chinned Honeyeater, Barking Owl, Koala, Superb Parrot, Grey-Crowned Babbler and Diamond Firetail. The assessments indicated that continued opal mining in its current form, is likely to result in a significant impact on these species through the loss and modification of habitat. As a result of these assessments, it has been recommended that further assessment is undertaken within OPA 4, to the level of a Species Impact Statement, in order to better understand the likely impacts on flora and fauna (see Section 7.2.2)*'. Despite these conclusions, the REF checklist (Appendix A of the same report) states there will not be any significant impacts.

(d) any reduction of the aesthetic, recreational, scientific or other environmental quality or value of a locality

Consideration: REF-04 provides a summary checklist (Appendix A p.109) which refers the reader to Section 6: this section concludes no significant impact.

Comment: The summary checklist (REF-04, Appendix A p.109) concludes that a significant impact is unlikely and refers the reader to Section 6 for discussion. **S**ection 6.14 (Precautionary Principle) notes that 'Lack of knowledge of the regional impacts of opal mining and the current environmental condition within OPA 4 has led to a recommendation of a stages opening of the opal prospecting area and further investigations into the sensitivity of the area', although further studies were restricted to the properties of Barfield and Kurrajong.

Section 6.2 of the report describes the potential impacts in OPA 4 thus: '*Similar impacts would be expected to occur within OPA 4 as the soils and vegetation are of the same type. Impacts to the sensitive Narran Lakes catchment should be avoided …'* (emphasis added). However, the document fails to discuss how the effects of a range of impacts (associated with opal puddling, dam, stockpiling or depositing of overburden, ore or tailings and storing of fuel, machinery and equipment) would be avoided within the catchment of either Narran Lake or the Narran Lakes Nature Reserve, 82% of which occur within the declared Ramsar area.

(e) any effect on a locality, place or building having aesthetic, anthropological, archaeological, architectural, cultural, historical, scientific or social significance or other special value for present or future generations

Consideration: REF-04 provides a summary checklist (Appendix A p.109) which refers the reader to Section 6: this section concludes that a significant impact is likely.

Comment: Effects on matters considered under this heading are beyond the scope of this review. However, of Aboriginal Cultural Heritage, the Narran Lakes Plan of Management states that:

> *'…The distinctive suite of sites at Narran Lake is probably not found elsewhere in north west NSW (Witter, 1986). Narran Lake is the only area within much of north west NSW which has the stratigraphic controls necessary for intensive archaeological research and technological analysis of culture sequences (Geering and Roberts, 1993). Some sites contain organic material which will be vital for answering questions such as whether the variation in stone artefact assemblages is due solely to chronological changes in artefact manufacture or more directly linked to environmental factors and/or specialised site functions…'.*

(f) any impact on the habitat of protected fauna (within the meaning of the National Parks and Wildlife Act 1974)

Comment: The summary checklist (REF-04, Appendix A p.109) concludes that a significant impact is likely and refers the reader to Section 6.4 for discussion. Contrary to this, Section 6.4 deals with cultural heritage. In fact, the information is provided under Section 6.3, p 13.

The REF (Section 6.3, p 13) describes parallels between current impacts in OPAs 1-3 and OPA 4 '*Quality of faunal habitat ranged from low to high across the Narran-Warrambool Reserve. Areas of low habitat value occur predominantly in mining areas and associated access areas with corridors of higher quality vegetation in between. Areas of high quality habitat contained a continuous canopy of vegetation, understorey and diverse ground cover, fallen branches, logs and leaf litter. Low quality habitat areas generally lacked a diverse ground cover (monocultures of Buffel Grass were observed in some low value habitat mining areas), lacked woody debris, and had a fragmented overstorey of canopy and understorey vegetation. Low value habitat areas also included compacted soil that has resulted in a loss of habitat for some reptiles and small mammals.*' As discussed above (see Fauna), many of the

recommendations contained in the BA-03 and the approach adopted in the REF-04 examined above are absent from the BA-06 report; noteworthy is the statement in REF-04 (p.6-16) recommending '*further investigation... to the level of a Species Impact Statement in developing a biodiversity plan for OPA 4*', yet the impact assessments in the Barfield and Kurrajong report (BA-06) conclude that mining in that part of OPA 4 will not create significant impacts on any threatened taxa.

(g) any endangering of any species of animal, plant or other form of life, whether living on land, in water or in the air

Comment: The summary checklist (REF-04, Appendix A p.109) concludes that a significant impact is likely and refers the reader to Section 6.4 for discussion. Contrary to this, Section 6.4 deals with cultural heritage. In fact, the information is provided under Section 6.3.

The REF (section 6.3, p.15) describes impacts on fauna within the currently mined areas of OPAs 1 to 3, including broader factors such as the removal of native vegetation, compaction and erosion of soils and removal of woody debris. It further notes (p.16) that a number of threatened fauna species have been specifically listed (NSW Scientific Committee Key Threatening Process listing, 12/12/2003) as depending on dead wood and dead trees, including '*... species likely to occur in OPA 4 such as*: *Five-clawed Worm Skink (*Anomalopus mackayi*); Pink Cockatoo (*Cacatua leadbeateri*); Red-tailed Black-cockatoo (*Calyptorhynchus banksii*); Glossy Black-cockatoo (*Calyptorhynchus lathami*); Barking Owl (*Ninox connivens*); Superb Parrot (*Polytelis swainsonii*); White-browed Treecreeper (*Climacteris erythrops*); Grey-crowned Babbler (*Pomatostomus temporalis*); and Spotted-tailed Quoll (*Dasyurus maculatus*)*'. Despite the foregoing, there is no further discussion of possible methods of mitigation or amelioration of the effects of this Key Threatening Process. Similarly, the BA-06 report describes only one KTP as being of relevance (*Clearing of native vegetation*), even though the earlier BA-03 and REF-04 refer to other KTPs such as *Predation by the European Red Fox* and *Predation by the feral cat.* See the relevant sections above for detailed comments on the adequacy of the previous survey and BA-03 report on which REF-04 is based, and comments on the adequacy of the subsequent Barfield and Kurrajong report (BA-06).

(h) any long-term effects on the environment,
(i) any degradation of the quality of the environment,
(j) any risk to the safety of the environment,
(k) any reduction in the range of beneficial uses of the environment,
(l) any pollution of the environment,

Comment: REF-04 provides a summary checklist (REF-04, Appendix A p. 109) which refers the reader to Section 6: it states **no significant impact** for Points (i), (j), (k) and (l) and **a significant impact** for Point (h). Section 6 deals with a wide range of factors. However, a number of issues have not been addressed adequately. These include:

- *impacts on soils associated with erosion, compaction and subsidence* (REF p.8-1). The soft red soils known from the area are prone to erosion and gullying [78], yet few ameliorative measures have been considered. Thoms *et al.* (2006) note that '*rates of sedimentation on the Lower Balonne floodplain have increased by an order of magnitude (1.63 to 11.06cm year-1) because of increases in sediment supply resulting from upstream land use changes'* [79]. The effects of development within the catchments is discussed by a number of other authors [80]; *given the mineralisation processes of substrate materials it is considered unlikely that mullock materials contain other contaminants such as heavy metals, or if present they are unlikely*

78 Department of the Environment, Water, Heritage and the Arts Australian above at n 24, 6.

79 Cooperative Research Centre for Freshwater Ecology above at n 2, 2.

80 (i) Cossart R., Thoms M. & Rayburg S. 2006. The infilling of a terminal flood plain-wetland complex. *Sediment Dynamics and the Hydromorphology of Fluvial Systems (Proceedings of a symposium held in Dundee, UK, July 2006). IAHS Publications* **306**: 389-398; (ii) Thoms M.C. 2003. Floodplain-river ecosystems: lateral connections and the implications of human interference. *Geomorphology* **56**: 335-349.

to be bioavailable. (REF-04 p.6-7). REF-04 (p.6-7) states that '*Mullock is also a concern to some graziers who claim that the material may be contaminated. Some limited testing of this material has been carried out. Eight samples of mullock were tested by the Scone Research Service Centre - Soil Services, Department of Land and Water Conservation (1999). The testing included:*

- *particle size analysis;*
- *dispersibility;*
- *conductivity – a measure of salinity;*
- *pH;*
- *total nitrogen and phosphorus – a measure of nutrient level; and*
- *exchangeable cations – trace elements including sodium, potassium, calcium,*
- *magnesium and aluminium'*

It is unclear why standard agricultural tests have been undertaken on soils in circumstances where there have been concerns about the potential presence of contaminants. Appropriate testing of the mullock needs to be undertaken to ascertain the potential for surface contaminants and their potential release during heavy rain events. Levels of phosphorus and nitrogen also need to be clearly stated, along with an assessment of the potential for toxicity emanating from mullock dumps.

- *Bunds are created around mullock dumps and wet pudding areas to minimise runoff and erosion. However, mullock is highly dispersible (thus increasing the turbidity of runoff) and can be moderately saline. Ponded water/fines from puddling operations can kill vegetation where salinity levels are high.* (REF, S6.2, p6-7). Any increase in salinity levels in tributaries of the Darling River or its floodplains should be viewed with concern. The Narran system discharges to the Bogan River during flood events and salinity rates for Bogan are projected to exceed 800 EC by 2020 (MDBC 1999). Secondly, salinisation is specified as a significant threat for a range of bird taxa found in the Narran Lakes system, including the threatened species Australian Bittern (*Botaurus poiciloptilus*), Freckled Duck (*Stictonetta naevosa),* Brolga (*Grus rubicunda*) and Blue-billed Duck (*Oxyura australis*) (Garnett & Crowley 2000).
- *No extraction of surface should occur from the Narran River and associated wetland system within OPA 4* (REF p.7-4). Although the REF addresses current and proposed operations, it fails to address impacts associated with the current extraction of water from the Narran River for the Coocoran Field (REF p.6-2).
- The REF (p.6-2) suggests that '*approximated population of 5,000 people engaged or supported by mining activities outside the main town of Lightning Ridge (based on 1,700 dwellings outside Lightning Ridge and an average of 2.9 persons per household),* but fails to mention any requirements for bushfire management and impact assessment relating to the provision of asset protection zones for new camps.

(m) any environmental problems associated with the disposal of waste

Comment: The summary checklist (REF-04, Appendix A p.109) concludes that a significant impact is unlikely and refers the reader to Section 6.7 for discussion. Contrary to this, Section 6.7 deals with noise and vibration. In fact, the information is provided under Section 6.12 (Waster and Resources).

In Section 6.1.3 (Cumulative Effects), the author(s) states that '…*The current mining activities are likely to be having impacts on flora and fauna, cultural heritage, visual amenity and land use. The opening of OPA 4, even with appropriate mitigation measures in place, is likely to add to the cumulative impacts of opal mining in the Narran-Warrambool reserve…*'

Of the mitigative measures proposed in Section 6.1.2 (Recommendations and Mitigation Measures) to counter the impacts described, the author(s) state that '…

The following measures regarding waste and resources are recommended:

- *mullock dumps should only be created subject to specific guidelines/requirements;*
- *annual clean up campaigns should be jointly organised and funded by the Lightning Ridge Miners Association and Department of Mineral Resources to remove derelict machinery. Miners should be encouraged to participate in this activity;*
- *waste dumps and rubbish dumps should be of such design and construction that they can be easily rehabilitated and restored in such a manner that they will not be easily distinguishable from the surrounding landscape after restoration;*
- *mullock dumps should be fully rehabilitated within the same time frame as assigned to registered claims;*
- *wastewater disposal within the peroc should be investigated to determine whether the current practices are satisfactory from a public health viewpoint; and*
- *the use of renewable forms of energy should be encouraged where possible to reduce the quantity of non-renewable resources consumed…'*

However, further discussion defining how such impacts would be avoided is not clearly stated. In relation to waster-water disposal, the authors do not define any standards relating to practices being '*satisfactory from a public health viewpoint'*.

Section 5.3.2 of the REF states '*Consultation with Department of Environment and Conservation staff in relation to the proposed OPA 4 revealed a number of issues of concern:*

- *the nature of opal mining results in the disturbance of vegetation in particular the removal of large tracts of ground cover and understorey vegetation leaving large areas of bare soil. During rain periods the subsequent erosion of these areas can cause significant problems;*
- *the lakes within the Narran Lake Nature Reserve (Clear Lake and Back Lake) and Narran Lake proper are all shallow lakes of depth between one to one and a half metres. Many small catchments (tributaries) exist within OPA 4 that eventually deliver water to these lakes. If opal mining were to be conducted in close vicinity to the lakes any erosion that may occur will enter these tributaries and the eventually the lakes themselves;*
- *the implementation of a buffer zone around these lakes would be needed; and vegetation within OPA 4 is relatively undisturbed and is currently subject primarily to grazing by sheep and to a lesser extent by cattle. The retention of any remnant vegetation within this area is highly desirable.*

Additionally, section 6.2 of the report describes these issues and the potential impacts within OPA 4 thus: '*Similar impacts would be expected to occur within OPA 4 as the soils and vegetation are of the same type. Impacts to the sensitive Narran Lakes catchment should be avoided …'*. Despite the fact that approximately 30% (our estimate bases on topographic map in Appendix 1) of the Barfield and Kurrajong properties within OPA 4 drains into Narran Lakes catchment, the document fails to discuss how a range of impacts associated with opal mining (such as puddling, dams, stockpiling or depositing of overburden or tailings, and storing of fuel, access, housing, machinery and equipment) would be avoided or even alleviated within the catchment of Narran Lakes Nature Reserve, most of which is listed as a Ramsar site. The REF also fails to explain how a proposed buffer to would be applied, given that the boundaries of Narran Lake remain unmapped.

In relation to the application of the EPBC Act 1999 (S4.3.1, p.4-6), the REF asserts that '*In relation to prospecting and exploratory drilling activities, the Administrative Guidelines on Significance indicate that such activities would not be expected to have a significant impact on a matter of national environmental significance where the discharges, emissions and waste from the drilling* ***are contained and managed*** *in an environmentally sensitive manner. Underground mining activities however may have a significant impact on matters of national environmental significance.*' Conversely, p6-2 of the REF suggests that '*Water used for wet puddling operations is* ***returned to the environment***.' (Emphasis added). However, despite the environmental sensitivity of Narran Lake and Narran Lake Nature Reserve, no further mention is made in the impact assessment, even though the REF (p. 6-2) notes '*The dams in the Coocoran Field are supplemented by water pumped from the Narran River.*'

(n) any increased demands on resources (natural or otherwise) that are, or are likely to become, in short supply

Comment: REF-04 provides a summary checklist (Appendix A p.109) which refers the reader to Section 6 and states a significant impact is likely. Average annual rainfall for the region is 490 millimetres (section 6.5, p.6-25). Section 6.1, (p6-2) suggests that water usage for wet puddling to be in the order of 16-20,000 litres/hour, much of which is sourced from 'surface water' which '*is collected for mining and stock watering in dams and is supplemented with bore water. Water sourced from the Great Artesian Basin is used for mining activities near Lightning Ridge. The dams in the Coocoran Field are supplemented by water pumped from the Narran River.*' As discussed elsewhere in this review, Thoms *et al.* (2006) point out the sensitivity of the Narran Lakes system to decreased water flows, and further note that '*The influence of groundwater in the Narran Lake wetlands is uncertain and has been identified as a knowledge gap requiring further work.*' (Thoms *et al.* 2006; p.23). This statement, combined with information in Hatton and Evans (1998) that states that little is known of the interdependence between ground water and terrestrial vegetation, suggests that increased extraction of surface and ground water through new opal mining activities could have significant cumulative effects, particularly on sensitive environments within Narran Lakes. Further investigation of these effects is warranted before significant impacts can be safely ruled out, particularly given that Thoms *et al.* (2006) state (p. 22) that '*There is only one water level recorder for the Narran Lakes system. This is not sufficient to allow a detailed investigation of hydrology of the entire Narran system.*'

The *Narran Lakes Nature Reserve Plan of Management* (NPWS 2000) notes that '*In addition to the Narran wetlands, periodic inundation is vital for maintenance of the ecology of the whole Narran River floodplain, including for existing agricultural, domestic and stock use...*' and recommends that the volumes and natural flow regimes within the Narran Lakes system must be protected. Although a number of studies [81] suggest that declining trends in flow variability of the Lower Balonne, and Narran Lakes system have the potential to significantly alter ecological processes and that sedimentation is increasing by an order of magnitude of 1.63 to 11.06 cm year-1) [82]. Impact assessment needs to fully quantify the impacts associated with the potential tubidity and salinity caused by the discharge of waste water (Section 6.1, (p6-2) suggests that water usage for wet puddling to be in the order of 16-20,000 litres/hour), as well as any potential contamination caused within the surrounding environment.

Hydrological Review

A review of the hydrological information in REF-04 and BA-06 has been undertaken by Dr. David K. Robinson (Robinson Water Consultants) (report on ftp server), and is provided in summary below.

Summary

There two major interactions between the proposed mining activities and the water cycle:

1. The impacts on the water cycle itself and the magnitude of any extractive impacts and/or consequences of the disposal of water used in mining; and
2. The opportunity for overland flows and/or flooding to mobilise sediment/pollutants associated with mining activities which can then be transported to local receiving waters. These risk

81 *e.g.* (i) Ogden, R., Wilson, G., Quinn, G. and Thoms, M. (2003) New study to throw light on water needs of the Narran Lakes - Jun 13 2003, CRCFE, Canberra - Media Release; (ii) Thoms, M., Quinn, G., Butcher, R., Phillips, B., Wilson, G., Brock, M. and Gawne, B. (2002) Scoping study for the Narran Lakes and lower Balonne floodpain management study. CRCFE technical report 3/2002, CRC for Freshwater Ecology, Canberra; and (iii) Thoms M.C. (2003). Floodplain-river ecosystems: lateral connections and the implications of human interference. *Geomorphology* 56: 335-349.

82 Thoms, M., Quinn, G., Butcher, R., Phillips, B., Wilson, G., Brock, M. and Gawne, B. (2002) Scoping study for the Narran Lakes and lower Balonne floodpain management study. CRCFE technical report 3/2002, CRC for Freshwater Ecology, Canberra.

associated with these threats is directly related to how well the mining activities are managed.

Soil and Water Management
The REF and other related documents identify the following impacts of the mining operations on the surface catchment:

- Mullock or spoil heaps are created adjacent to operational and abandoned mines. The material in these heaps may be mobilised by rainfall and/or overland flows. These waste heaps need to be better managed to ensure that they do not become a potential source sediments and containments.
- The access roads to mines are a potential point of scour and erosion.
- The harvesting of local timber for domestic and mining use may provide an opportunity for increased soil erosion.
- The disposal of mine wastes such as oils, etc. is a potential source of pollutants.
- The lack of effective rehabilitation after the cessation of mining is a potential long term risk.

Requirement for a Mining REF
The Proponent's REF does not provide sufficient information/data/analysis to be able to determine whether there will likely be *'a significant effect on the environment'* from the principle identified impacts; namely:

- Impact on the water balance of the local streams that cross the proposed mining lease due to extractions and changed runoff regimes;
- Impact on the groundwater resource of extractions for both domestic and mining activities.
- Impact of changed/increased soil/sediment export from the lease area due to mining operations and abandoned mine areas.
- Impact on the drainage system of increased sediment load.
- Changed water balance for receiving water such as Narran Lake.
- Impact on Narran Lake of the increased sediment load due to mining.

Conclusion
The Proponents for the mining proposal need to model/estimate the following factors in order to demonstrate that there are not *'significant effects'* which would trigger an EIS:

- How the extraction of surface and ground water will change the hydrologic balances in the area and evidence that these changes will not adversely affect the long term sustainability of the local water resources.
- That the management of mine operations and the long term risks associated with the disposal of mine tailings will not increase sediment transport to the detriment of the long term stability of the local drainage system and receiving waters, especially the RAMSAR declared lakes.
- That the mobilisation of mine wastes by surface runoff will not allow the release of pollutants into the local waterways.

(o) any cumulative environmental effect with other existing or likely future activities
Consideration: REF-04 provides a summary checklist (Appendix A p.109) which refers the reader to Section 6.11 and states that no significant impact is likely.

Comment: Section 6.11 deals with social and economic aspects. Elsewhere in the report (section 6.13), the REF discusses the potential for cumulative effects: '*Mineral claims within OPAs 1-3 cover an area of approximately twenty square kilometres that is already likely to be having an impact on the environment. Additionally*

there will be further impacts from associated access tracks and infrastructure such as mullock dumps. The current mining activities are likely to be having impacts on flora and fauna, cultural heritage, visual amenity and land use. The opening of OPA 4, even with appropriate mitigation measures in place, is likely to add to the cumulative impacts of opal mining in the Narran-Warrambool reserve.' The REF also states (p.6-16) '*Currently, there are approximately six thousand mineral claims lodged with the Department of Mineral Resources with most lodged within a twenty square kilometre area. The cumulative affect* [sic] *of intensive mining in these areas is likely to have a* ***significant impact*** *upon both flora and fauna*' (emphasis added). The REF also states (p6-37) '*Without appropriate conservation planning within OPA 4, the combined effect of vegetation clearing from mining and agriculture may have a significant impact on biological resources of the area.*' Despite these comments, the REF concludes (Table A.1: Clause 228 Checklist, Appendix A) that there will be no significant cumulative impacts.

Key Threatening Processes

BA-06 discusses the potential for opal mining to contribute to the Key Threatening Process (KTP) *Clearing of native vegetation,* yet does not mention the KTP *Removal of dead wood and dead trees* referred to in BA-03 or REF-04; similarly, REF-04 mentions the KTP *Clearing of native vegetation* even though both state that vegetation will be cleared as a result of a number of processes associated with opal mining.

While BA-03 mentions the KTPs *Predation by the European Red Fox* and *Predation by the feral cat,* the REF-04 does not; neither BA-03/BA-06 nor REF-04 discuss several other KTPs which are a conceivable consequence of the disturbances and impacts of opal mining, although some KTPs would not have been listed at the time the BA-03 was prepared. Potentially relevant KTPs (which opal mining may directly result in, or indirectly contribute to) are:

- *Removal of dead wood and dead trees;* (12/12/2003)
- *Invasion of native plant communities by exotic perennial grasses;* (12/09/2003)
- *Bushrock removal;* (05/11/1999)
- *Ecological consequences of high frequency fires;* (24/03/2000)
- *Infection of native plants by* Phytophthora cinnamomi; (13/12/2002)
- *Competition and grazing by the feral European rabbit;* (10/05/2001)
- *Competition and habitat degradation by feral goats;* (12/12/2004)
- *Loss of hollow-bearing trees;* (05/10/2007)
- *Predation by the European red fox;* (20/05/1998) and
- *Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.* (31/05/2002).

NB. Dates refer to the listing of the Key Threatening Process on the schedules of the TSC Act.

Three of the above processes are of particular concern: *Removal of dead wood and dead trees, Loss of hollow-bearing trees* and *Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands.* Aside from being listed as a KTP, loss of dead wood and dead trees (as a result of clearing of vegetation) will create impacts on several fauna species (as discussed above). As noted in REF-04 BA-03 and the BA-06 reports, areas of mature Poplar Box vegetation on ridge country in the area are those areas most likely to be explored for opal; mature trees lost could include hollow-bearing trees, and there is nothing in any of the reports to indicate that the distribution of hollow-bearing trees has been the subject of adequate searches.

Lastly, with respect to the KTP *Alteration to the natural flow regimes of rivers, streams, floodplains and wetlands,* BA-06 (p. 40) states that the study area '*is not within the catchment of Narran Lakes*': this assertion is, however, open to question. Inspection of topographic maps of the area shows that at least the northern parts of 'Kurrajong' and a minor part of 'Barfield' initially flow northwards and then north-west towards the Narran River. REF-04 also notes feedback from consultation with DECC (then

DEC) staff, who express concern that '*Many small catchments (tributaries) exist within OPA 4 that eventually deliver water to these lakes*'.

Mitigation and Amelioration of Impacts

Both the REF and biodiversity assessments propose a 3km buffer around 'the lake' (REF-2004 pp.6-8 and 6-17) or 'these lakes' (possibly Back Lake and Clear Lake, referred to earlier in the same paragraph (BA-03), yet the status of any such buffer zone (whether this proposal been formally adopted by DPI and DECC) is not clear. It is also not clear which 'lake' or 'lakes' will be buffered. Conversely, BA-06 makes no mention of any such buffer zone to any lake or the Nature Reserve, despite the fact that the study area is directly adjacent to lands within the south-eastern extension to Narran Lakes Reserve which are managed by DECC. Section 5.3.2 (REF-2004) (Department of Environment and Conservation - National Parks and Wildlife Service) states that '…*the lakes within the Narran Lake Nature Reserve (Clear Lake and Back Lake) and Narran Lake proper are all shallow lakes of depth between one to one and a half metres. Many small catchments (tributaries) exist within OPA 4 that eventually deliver water to these lakes. If opal mining were to be conducted in close vicinity to the lakes any erosion that may occur will enter these tributaries and the eventually the lakes themselves*…'. In order to mitigate against the potential for impacts to the abovementioned lakes, the REF suggests that '… a minimum buffer zone of three kilometres is proposed around Narran Lake and this buffer would also prohibit the establishment of wet puddling operations and mining camps to safeguard water quality…'. However, the bounds of Narran Lake have not been delineated. Consequently, it is unclear as to where the 3km buffer would extend from. Additionally, these measures do not provide any protection for the sensitive environments of the Ramsar listed Narran Lakes Nature Reserve.

The REF fails to discuss limitations associated with acid sulphate soils despite mounting evidence of their association with the dry phase of inland freshwater systems. Baldwin *et al.* [83] describes the potential for acid sulphate soils thus: '…*Sulfidic sediments (potential acid sulfate soils) are considered a concern primarily in coastal regions, but mounting evidence indicates that they are also an issue in freshwater ecosystems (Fitzpatrick* et al. *1996; Sullivan* et al. *2002), particularly those impacted by secondary salinization. In a recent survey of 81 wetlands in the Murray-Darling Basin, more than 20% had evidence for the presence of sulfidic sediments at levels that could lead to ecological damage (Hall* et al. *2006). Implementing a drying phase in wetland management is increasingly common (Casanova & Brock 2000), but if sulfidic sediments are present, drying can oxidize sulfidic minerals and generate acid (actual acid sulfate soils). For example, the partial drawdown of a wetland in western New South Wales resulted in an extensive fish kill because of exposure and oxidation of sulfidic sediments leading to acidification (McCarthy* et al. *2006). Oxidation of sulfidic sediments can also cause other problems such as anoxia in the overlying water column and mobilization of metals from the sediments (Sullivan* et al . *2002)*…'

6.0 COMMONWEALTH ASSESSMENT

6.1 *Environment Protection & Biodiversity Conservation Act 1999* (EPBC Act) Assessment

The EPBC Act 1999 Cwth contains provisions for the listing of species, ecological communities and threatening processes, and provides for assessment of potential impacts on "matters of national environmental significance" by the Minister for the Environment. The Act provides means for assessing the environmental impact of developments or activities where "*matters of national environmental significance*" may be affected. Intra-nationally, bilateral agreements (between Commonwealth and State governments, and hence local government level) or ministerial declarations are an attempt to delegate environmental assessment required by the Commonwealth to individual states and territories "minimises duplication" between the Commonwealth and the States. Since the Act was introduced,

83 Baldwin, D. S, Hall, K.C., Rees, G. N. and Richardson, A. J. 2007. Development of a protocol for recognizing sulfidic sediments (potential acid sulfate soils) in freshwater wetlands. Ecological Management & Restoration.Vol 8 No 1

only six bilateral agreements have been finalised [84]: where no agreement is in place, or where the matter is not delegated, the effects of activity on "*matters of national environmental significance*" [85] are assessed at the discretion of the Minister for the Environment (Cwth), where the proponent refers that matter for federal assessment [86].

REF-04 states (S4.3, p 39) that '*Under Section 524* [87] *of the Environment Protection and Biodiversity Conservation Act 1999 [it states that] a decision by a government body to grant a governmental authorisation (however described) for another person to take an action is not an action. This means that the Department of Mineral Resources is not the proponent of opal Opal Mining at Lightning Ridge and that individual miners would be responsible for submitting a referral related to individual actions. While Section 69 states that a State agency that is aware of a proposal by a person to take an action may refer the proposal to the Commonwealth Minister for a decision whether or not the action is a controlled action, if the State agency has administrative responsibilities relating to the action this would only apply once a specific action has been proposed. In relation to prospecting and exploratory drilling activities, the Administrative Guidelines on Significance indicate that such activities would not be expected to have a significant impact on a matter of national environmental significance where the discharges, emissions and waste from the drilling are contained and managed in an environmentally sensitive manner. Underground mining activities however may have a significant impact on matters of national environmental significance.*' However, the REF then states (S6, p 17) that '*Similar to the state Threatened Species Conservation Act 1995, a blanket assessment method without more in depth survey has concluded a significant impact is likely and, therefore, further investigation is recommended to assist in developing a biodiversity plan for OPA 4 and avoiding significant impacts on threatened and migratory species.*

Note that a decision by a state government body to grant an approval or a licence is not deemed an "action" under s.524 of the EPBC Act 1999 [88]. REF-04 states (S4.3, p 39) that '*Under Section 524* [89] *of the Environment Protection and Biodiversity Conservation Act 1999 [it states that] a decision by a government body to grant a governmental authorisation (however described) for another person to take an action is not an action. This means that the Department of Mineral Resources is not the proponent of opal Opal Mining at Lightning Ridge and that individual miners would be responsible for submitting a referral related to individual actions.* Note that, in circumstances where referrals to the Commonwealth Minister for the Environment, Water, Heritage and the Arts are not made by individual licensees, Division 18A of Part 17 of the EPBC Act provides that landholders will be liable to civil and criminal penalties for certain breaches carried out by others on the landholder's land. Given the controlling provisions of the EPBC Act (including Ramsar

84 New South Wales, New South Wales relating to the Sydney Opera House, Queensland, Tasmania, Northern Territory and Western Australia.

85 Potential controlling provisions under the Commonwealth Environment Protection & Biodiversity Conservation Act 1999 (Cwth). Sub-section 15B & 15C (National Heritage place); ss. 16 & 17B (Ramsar wetland); ss. 18 & 18A (threatened species or threatened ecological communities) and ss. 20 & 20A (migratory species).

86 Compliance and enforcement clauses in the Act encompass numerous factors, but do not identify non-referral of developments or activities where "matters of national environmental significance" may be affected: the rights of third parties to report non-referral are not recognised by the Act and subordinate legislation. Even if it is clear that the action of a proponent would trigger the requirement for impact assessment under the EPBC Act, members of the public cannot refer that action to the Minister.

87 A decision by a state government body to grant an approval or a licence) is not an action under the EPBC Act Environment Protection and Biodiversity Conservation Act 1999 Act No. 91 of 1999 as amended s.524 Things that are not *actions*

88 Compliance and enforcement clauses in the Act encompass numerous factors, but do not identify non-referral of developments or activities where "matters of national environmental significance" may be affected: the rights of third parties to report non-referral are not recognised by the Act and subordinate legislation. Even if it is clear that the action of a proponent would trigger the requirement for impact assessment under the EPBC Act, members of the public cannot refer that action to the Minister.

89 A decision by a state government body to grant an approval or a licence) is not an action under the EPBC Act Environment Protection and Biodiversity Conservation Act 1999 Act No. 91 of 1999 as amended s.524 Things that are not *actions*

Wetlands), the DPI needs to clearly outline the steps which would ensure that individual landholders could not be held in breach of the EPBC Act 1999.

7.0 CONCLUSION

A Department of Primary Industries press release on OPA 4 [90] notes '*The decision on the establishment of the new Opal Prospecting Area 4, under the provisions of the Mining Act had been reached after exhaustive studies had taken place. This included a major environmental study commissioned by the NSW Government over the Narran-Warrambool Mining Reserve at Lightning Ridge, which provided key environmental information to help manage future development of opal mining and prospecting activities... To ensure future opal prospecting and mining in OPA 4 occurs in an efficient and responsible manner, only a limited number of opal prospecting blocks will be opened up for exploration at any one time. Initially, this will be areas where there are no major environmental issues, or where significant mining activity has already occurred.*' Review of the REF documents (REF-04; BA-03 AND BA-06) relating to OPA 4 shows that the field surveys and reporting are not sufficient to show clear evidence of areas within OPA 4 where '*there are no major environmental issues*', nor do several contradictory statements within REF-04 (for example, regarding cumulative impacts) engender confidence in the conclusions reached. It is not clear how opening limited numbers of blocks at a time will reduce either immediate impacts or the overall cumulative effects of opal mining, particularly on the sensitive Narran Lakes and Narran Lakes Nature Reserve. Note that, in evaluating the significance of impacts in environmentally sensitive locations, the Department of Planning [91] state that '*the impacts of activities undertaken in environmentally sensitive areas are more likely to be significant than similar activities proposed in less sensitive locations. Relatively small activities carried out in sensitive locations can result in substantial impacts on the environment. A precautionary approach should be adopted for activities proposed in locations known to be environmentally sensitive, including careful investigation of alternative and mitigative strategies.*'

As detailed elsewhere in this review, in general, the methods, timing and survey effort outlined in BA-03 and BA-06 are inadequate, and appear flawed in several respects. Survey methods for threatened flora and fauna species are poorly described, and those descriptions of survey effort that are given suggest inadequate survey effort and, occasionally, a limited understanding of the ecology of those threatened taxa which may occur. In addition, the timing of searches for threatened species is questionable; mention is made of the drought conditions prevailing at the time of the survey, yet the limitations imposed by weather conditions do not appear to have flowed through to the impact assessments. No vegetation mapping has been supplied in REF-04 or BA-03. The vegetation mapping for BA-06 does not provide sufficiently detailed information, is not of a scale which allows for interpretation of the results documented in the accompanying report, and is based heavily on 1:100 000 scale mapping supplied by NFRPC (2004); this was based largely on satellite imagery interpretation, a method which Benson *et al.* (2006) note as poor at detecting some communities including Myall *Acacia pendula* woodland, itself listed as an Endangered Ecological Community under the Schedules to the TSC Act 1995.

In light of the above and the uncertainties associated with the impact assessment, it is reasonable to suggest that an EIS is required which fully considers the potential impacts on biota. Amongst other factors, an EIS should:

- fully quantify the impacts associated with the potential turbidity and salinity caused by the discharge of waste water (see Section 6.1, (p6-2) which suggests that water usage for wet puddling to be in the order of 16-20,000 litres/hour), as well as any potential contamination caused within the surrounding environment by run-off from mullock dumps;

90 DPI News Release. 2005. http://www.dpi.nsw.gov.au/archive/news-releases/minerals-and-petroleum/2005/new-opal-prospecting-area

91 Department of Urban Affairs and Planning (Now Department of Planning). above at n 3, 2.

- investigate, examine and assess potential impacts on threatened flora, vegetation communities, fauna and habitats across the entire OPA 4 site, as well as in OPAs 1-3. Given the geographic extent of the survey area, the limitations outlined in the BA-2003 survey [92] (p2: only three days in August 2003 were dedicated to field surveys for flora and fauna in an estimated area of 500km^2), and the restricted survey provided in BA-2006 [93] (broad habitat-based surveys (already identified in the preceding BA-2003 and REF-2004 as being less than ideal), further survey needs to be undertaken across the entire study area.
- consider the objectives of the Narran Lake Nature Reserve Plan of Management [94], as well as any other guiding material (*e.g.* Ramsar Convention);
- undertake targeted surveys for threatened flora and fauna during appropriate season(s). In circumstances where survey has not been undertaken in appropriate season for certain groups of fauna and some flora species, threatened species which are known from the area should be dealt with in the affirmative for the purposes of impact assessment. Threatened species searches should also be undertaken for flora species, and the occurrence of endangered ecological communities must be appropriately delineated;
- make further efforts to ground-truth existing vegetation communities and refine vegetation mapping. That provided is at a scale inappropriate for mapping features of ecological significance, and relies heavily on modelled vegetation mapping which itself is known to be unreliable in determining some endangered vegetation types;
- more fully examine potential hydrological impacts on the sensitive environments of Narran Lakes and Narran Lakes Nature Reserve (no hydrological study has been undertaken [95]). Given the projected impacts, the function of any proposed mitigation, such as a 3km buffer, needs to be fully explored and justified; and
- include in the examination of potential impacts the need to consider Key Threatening Processes as well as recovery actions (NSW and Cwth) and conservation advice (Cwth) (*e.g. Anomalopus mackayi (Five-clawed Worm-skink, Long-legged Worm-skink)* Conservation Advice under EPBC Act).

Note that, in circumstances where referrals to the Commonwealth Minister for the Environment, Water, Heritage and the Arts are not made by individual licensees, Division 18A of Part 17 of the EPBC Act provides that landholders will be liable to civil and criminal penalties for certain breaches carried out by others on the landholder's land. Given the controlling provisions of the EPBC Act (including Ramsar Wetlands), the DPI needs to clearly outline the steps which would ensure that individual landholders could not be held in breach of the EPBC Act 1999.

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92 Thompson above n 4(i).

93 Parsons Brinckerhoff Australia Pty. Ltd above n 4(ii).

94 In addition to the above general objectives the management of Narran Lake Nature

Reserve will be subject to the following more specific objectives:

maintenance of diverse, healthy and productive wetland habitat and the value of the reserve as a major waterbird breeding area;

improvement in knowledge of the species diversity and management needs of the reserve;

fulfilment of the objectives of the Ramsar Convention and other international nature conservation agreements to which Australia is signatory;

protection of significant Aboriginal sites from further erosion and improvement in knowledge about traditional Aboriginal use of the area;

encouragement of regeneration of a natural vegetation cover in areas degraded by past grazing;

control, and if possible elimination, of introduced species; and

promotion of community awareness and appreciation of the conservation value of the Narran Lake system.

95 Cooperative Research Centre for Freshwater Ecology above at n 2, 2.

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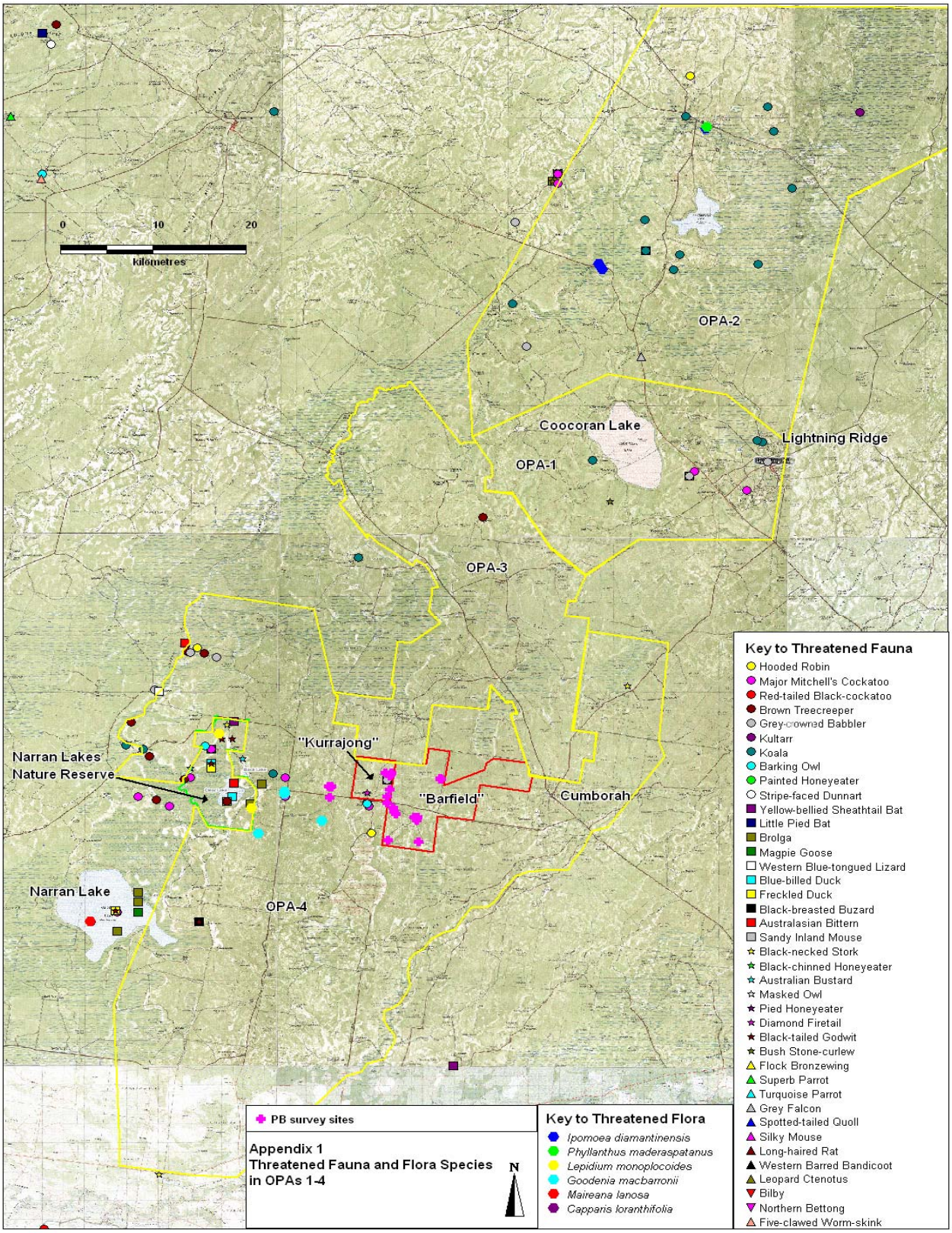
Appendix 1 Listed Species and ecological communities (source: NSW DECC)/topographic map (source: Dept Lands) and survey sites documented for BA-06.



Appendix 2 Table 2 Listed Species and ecological communities

Scientific Name	Common Name	Type	Conservation Status		Detected	Significance		
			TSC Act [96]	EPBC Act [97]		s.5A [98]	s.5A [99]	EPBC [100]
Capparis loranthifolia var. *loranthifolia*	Narrow-leafed Bumble	Flora	E1	-				
Lepidium monoplocoides	Winged Peppercress	Flora	E1	-				
Maireana lanosa	-	Flora	E4	-				
Goodenia macbarronii	McBarron's Goodenia	Flora	V	-		2006		
Ipomoea diamantinensis	Desert Cow-Vine	Flora	E1	-				
Phyllanthus maderaspatanus	Phyllanthus maderaspatensis	Flora	E1	-				
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin		Threatened Ecological Community		E				
Anseranas semipalmata	Magpie Goose	Birds	V	-				
Oxyura australis	Blue-billed Duck	Birds	V	-				
Stictonetta naevosa	Freckled Duck	Birds	V	-				
Ixobrychus minutus	Little Bittern	Birds						
Botaurus poiciloptilus	Australasian Bittern	Birds	V	-				
Ephippiorhynchus asiaticus	Black-necked Stork	Birds	E1	-				
Hamirostra melanosternon	Black-breasted Buzzard	Birds	V	-				
Falco hypoleucos	Grey Falcon	Birds	V	-				
Grus rubicunda	Brolga	Birds	V	-				
Ardeotis australis	Australian Bustard	Birds	E1	-				
Burhinus grallarius	Bush Stone-curlew	Birds	E1	-		2003		
Limosa limosa	Black-tailed Godwit	Birds	V	-				
Phaps histrionica	Flock Bronzewing	Birds	E1	-				
Calyptorhynchus banksii	Red-tailed Black-Cockatoo	Birds	V	-		2003		
Cacatua leadbeateri	Major Mitchell's Cockatoo	Birds	V	-	Detected fringe of	2003; 2006		

[96] *Threatened Species Conservation Act 1995* status - See Table 3 for explanation of codes

[97] *Environment Protection and Biodiversity Conservation Act 1999*

[98] *Environmental Planning and Assessment Act 1979* s.5a provided

[99] Deemed Significant *Environmental Planning and Assessment Act 1979* s.5a

[100] Deemed Significant under the *Environment Protection and Biodiversity Conservation Act 1999*

Scientific Name	Common Name	Type	Conservation Status		Detected	Significance		
			TSC Act [96]	EPBC Act [97]		s.5A [98]	s.5A [99]	EPBC [100]
					study area [101] 2003			
Polytelis swainsonii	Superb Parrot	Birds	V	V	Detected fringe of study area [102] 2003	2003		
Neophema pulchella	Turquoise Parrot	Birds	V	-				
Ninox connivens	Barking Owl	Birds	V	-		2003	2003	
Tyto novaehollandiae	Masked Owl	Birds	V	-				
Climacteris picumnus	Brown Treecreeper	Birds	V	-		2006		
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	Birds	V	-		2003; 2006	2003	
Grantiella picta	Painted Honeyeater	Birds	V	-				
Certhionyx variegatus	Pied Honeyeater	Birds	V	-				
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	Birds	V	-	Detected OPA4 [103] 2003; Detected [104] 2006	2006		
Pomatostomus halli	Hall's Babbler	Birds	V	-				
Stagonopleura guttata	Diamond Firetail	Birds	V	-		2003; 2006		
Antechinomys laniger	Kultarr	Mammal	E1	-				
Macrotis lagotis	Bilby	Mammals	E4	-				
Phascolarctos cinereus	Koala	Mammals	V	-		2003	2003	
Dasyurus maculatus	Spotted-tailed Quoll	Mammals	V	-				
Sminthopsis macroura	Stripe-faced Dunnart	Mammals	V	-				
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Mammals	V	-	Detected [105] 2006	2006		
Chalinolobus picatus	Little Pied Bat	Mammals	V	-				
Ctenotus pantherinus ocellifer	Leopard Ctenotus	Mammals	E1	-				
Pseudomys hermannsburgensis	Sandy Inland Mouse	Mammals	V	-				
Nyctophilus timoriensis (South-eastern form)	Eastern Long-eared Bat	Mammals	-	V				
Rattus villosissimus	Long-haired Rat	Mammals	V	-				
Nyctophilus timoriensis	Greater Long-eared Bat (south	Mammals	V	V		2006		

101 Thompson above n 4(i), 3.

102 Ibid.

103 Ibid.

104 Parsons Brinckerhoff Australia Pty. Ltd above n 4(ii), 3.

105 Ibid.

Scientific Name	Common Name	Type	Conservation Status		Detected	Significance		
			TSC Act [96]	EPBC Act [97]		s.5A [98]	s.5A [99]	EPBC [100]
	eastern form)							
Antechinomys laniger	Kultarr	Mammals	E1	-				
Vespadelus baverstocki	Inland Forest Bat	Mammals	V	-	Detected [106] 2006	2006		
Perameles bougainville fasciata	Western Barred Bandicoot (mainland)	Mammals	E4	-				
Bettongia tropica	Northern Bettong	Mammals	E4	-				
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	Mammals	V	-				
Pseudomys apodemoides	Silky Mouse	Mammals	E1	-				
Rattus villosissimus	Long-haired Rat	Mammals	V	-				
Maccullochella peelii peelii	Murray Cod	Ray-finned fish	-	V				
Haliaeetus leucogaster	White-bellied Sea-Eagle	Migratory Terrestrial Bird Species	-	Listed Marine; M				
Hirundapus caudacutus	White-throated Needletail	Migratory Terrestrial Bird Species	-	Listed Marine; M; JAMBA				
Merops ornatus	Rainbow Bee-eater	Migratory Terrestrial Bird Species	-	Listed Marine; M; JAMBA				
Ardea alba	Great Egret	Migratory Wetland Bird Species	-	CAMBA as *Egretta alba;* JAMBA as *Egretta alba*				
Ardea ibis	Cattle Egret	Migratory Wetland Bird Species	-	CAMBA as *Ardeola ibis; JAMBA as Ardeola ibis*				
Gallinago hardwickii	Latham's Snipe	Migratory Wetland Bird Species	-	Listed Marine; CAMBA; *JAMBA*				
Rostratula benghalensis s. lat./ *Rostratula australis*	Painted Snipe	Migratory Wetland Bird Species	E	Listed Marine; CAMBA		2003		
Apus pacificus	Fork-tailed Swift	Migratory Marine Bird Species	-	Listed Marine; CAMBA, JAMBA				

106 Parsons Brinckerhoff Australia Pty. Ltd above n 4(ii), 3.

Scientific Name	Common Name	Type	Conservation Status		Detected	Significance		
			TSC Act [96]	EPBC Act [97]		s.5A [98]	s.5A [99]	EPBC [100]
Ardea alba	Great Egret	Migratory Marine Bird Species	-	Listed Marine; CAMBA as *Egretta alba;* JAMBA as *Egretta alba*				
Ardea ibis	Cattle Egret	Migratory Marine Bird Species	-	Listed Marine; CAMBA as *Ardeola ibis JAMBA as Ardeola ibis*				
Anomalopus mackayi	Five-clawed Worm-skink	Reptile	-	V		2003	2003	2003
Elseya belli	Bell's Turtle	Reptile	-	V				
Tiliqua occipitalis	Western Blue-tongued Lizard	Reptile	V	-				

Table 3 Explanation of codes

Code	Description	Definition under the National Parks and Wildlife Act (NPW Act 1974) and the Threatened Species Conservation Act 1995 (TSC Act 1995)
U	Unprotected	Refers to fauna listed in Schedule 11 of the NPW Act 1974, and to flora not listed in Schedule 13 of the NPW Act 1974 or in the TSC Act 1995
P	Protected	Refers to fauna not listed in Schedule 11 of the NPW Act 1974
P 13	Protected Native Plants	Refers to flora listed in Schedule 13 of the NPW Act 1974
V	Vulnerable	Refers to fauna and flora species that are likely to become endangered unless the circumstances & factors threatening its survival or evolutionary development cease to operate (Schedule 2, TSC Act 1995).
E1	Endangered	Refers to fauna and flora species that are likely to become extinct in nature in NSW unless the circumstances and factors threatening its survival or evolutionary developments cease to operate; or, its numbers have been reduced to such a critical level, or its habitats have been so drastically reduced, that it is in immediate danger of extinction; or, it might already be extinct, but it is not presumed extinct (Schedule 1, part 1, TSC Act 1995).
E2	Endangered Population	Refers to a population where, in the opinion of the Scientific Committee, its numbers have been reduced to such a critical level, or its habitat has been so drastically reduced, that it is in immediate danger of extinction and it is not a population of a species already listed in Schedule 1, and: (a) it is disjunct and at or near the limit of its geographic range, or (b) it is or is likely to be genetically distinct, or (c) it is otherwise of significant conservation value. (Schedule 1, part 2, TSC Act 1995).
E4	Extinct	Refers to fauna and flora species that have not been located in nature during the preceding 50 years despite searching of known and likely habitats of that period (Schedule 1, part 4, TSC Act 1995).
C1	Critically Endangered Species	Refers to a species that is eligible to be listed as a ***critically endangered species*** if, in the opinion of the Scientific Committee, it is facing an extremely high risk of extinction in New South Wales in the immediate future, as determined in

Code	Description	Definition under the National Parks and Wildlife Act (NPW Act 1974) and the Threatened Species Conservation Act 1995 (TSC Act 1995)
		accordance with criteria prescribed by the regulations. (Schedule 1a, part 1, TSC Act 1995).

Appendix 3 Profiles of the threatened species detected on the NP&WS Atlas of NSW Wildlife Atlas database records which are known to occur in the area are provided below in Appendix 3 (source: Threatened Species Profiles DECC).

Phyllanthus maderaspatensis

Conservation status in NSW: Endangered
Description: Rigid forb 30-50 cm high, with slender angular branches. Leaves arranged in 2 regular rows on opposite sides of the branches, oblong-linear or wedge-shaped, 10-25 mm long, rounded or with a short point at tip, with white-rimmed stipules at the base. Flowers tiny and without petals, male and female on the one plant, borne in clusters in the leaf axils. Fruit a slightly flattened 3-lobed capsule about 3 mm in diameter, containing seeds covered with 10-12 rows of minute warts.
Location and habitat
Distribution: Recorded for the Brewarrina and Collarenebri districts in the north-western plains of NSW. Also occurs in Qld, the NT, SA and WA.
Habitat and ecology:

- Grows in floodplain areas on heavy soils and may rely on appropriate and intermittent rainfall and flooding events for its survival. The species is described as being a summer-growing annual and is thus dependent on seasonal conditions. Often associated with open grasslands and eucalypt woodlands in or near creek beds, and grassy flats and levees near watercourses.
- Flowering time is spring to summer, and the species is a summer-growing annual. Seeding is recorded in March. Occurs after summer rains and readily drops its leaves as it dries off.
- Plants are usually infrequent in abundance but have been recorded as common in disturbed areas.

Regional information: This species is found in the following catchment management authority regions. Click on a region name to see more details about the distribution, vegetation types and habitat preference of the species in that region.

- Lower Murray/Darling; Western

Threats

- May be limited by competition from other summer-growing annuals.
- Clearing of floodplain habitat (for irrigation and cropping).
- Roadside clearing.

Winged Peppercress *Phyllanthus maderaspatensis*

Conservation status in NSW: Endangered
National conservation status: Endangered
Description: Erect annual herb or perennial forb, 15-20 cm high, with angular and striped stems roughened with small warts. Leaves narrow and linear, mostly 2-7 cm long. Flowers small, borne in elongated clusters, the petals minute or absent. Fruit a 2-celled, flattened circular pod on a spreading stalk, 5 mm long and about 4 mm wide, with pointed wings extending to a narrow notch at the tip.
Location and habitat
Distribution: Widespread in the semi-arid western plains regions of NSW. Collected from widely scattered localities, with large numbers of historical records but few recent collections. There is a single collection from Broken Hill and only two collections since 1915, the most recent being 1950. Also previously recorded from Bourke, Cobar, Urana, Lake Cargelligo, Balranald, Wanganella and Deniliquin. Recorded more recently from the Hay Plain, south-eastern Riverina, and from near Pooncarie.
Habitat and ecology:

- Occurs on seasonally moist to waterlogged sites, on heavy fertile soils, with a mean annual rainfall of around 300-500 mm. Predominant vegetation is usually an open woodland dominated by Allocasuarina luehmannii (Bulloak) and/or eucalypts, particularly Eucalyptus largiflorens (Black Box) or Eucalyptus populnea (Poplar Box). The field layer of the surrounding woodland is dominated by tussock grasses.
- Recorded in a wetland-grassland community comprising Eragrostis australasicus, Agrostis avenacea, Austrodanthonia duttoniana, Homopholis proluta, Myriophyllum crispatum, Utricularia dichotoma and Pycnosorus globosus, on waterlogged grey-brown clay. Also recorded from a Maireana pyramidata shrubland.
- Flowers from late winter to spring, or August to October.

- The species is highly dependent on seasonal conditions. Occurs in periodically flooded and waterlogged habitats and does not tolerate grazing disturbance.
- The number of plants at each site varies greatly with seasonal conditions, but sites tend to be small in area with local concentrations of the plant. Has been recorded as uncommon to locally common with hundreds of plants at sites.

Regional information: This species is found in the following catchment management authority regions. Click on a region name to see more details about the distribution, vegetation types and habitat preference of the species in that region.

- Lachlan; Lower Murray/Darling; Murray; Murrumbidgee; Western

Threats

- Agricultural development (most of the former range of the species has been extensively used for agriculture, cropping and improved pasture).
- Habitat removal (small depressions that were former principal habitat eliminated by ploughing).
- Grazing (the species is highly palatable to rabbits and kangaroos).
- Disturbances associated with a Navy-owned communications tower, service roads and fire-breaks.
- Pugging and trampling by stock.

Narrow Goodenia *Goodenia macbarronii*

Conservation status in NSW: Vulnerable

Description: Narrow Goodenia is an annual or short-lived perennial herb to 30 cm tall. Its leaves, at the base of the plant, are fleshy and slightly toothed, to 11 cm long by 5 mm wide. The sprays of small yellow 'crinkly' five-petalled flowers are generally produced in spring and summer.

Location and habitat

Distribution: Narrow Goodenia grows on the western slopes of the Great Dividing Range in NSW, south from the Guyra and Inverell districts. It is widely distributed throughout the tablelands, western slopes and western plains. The species also occurs in north-eastern Victoria and the Darling Downs in Queensland. In NSW it has been recorded at Tingha, Guyra, the Warrumbungle Ranges, east of Rylstone, the Pilliga and Denobollie State Forests, the Narrabri, Coonabarabran, Torrington and Tocumwal districts, Grenfell, Weddin Mountain, Gungal, the Milthorpe district, and Holbrook (the Type locality).

Habitat and ecology:

- Flowers chiefly from October to March and is described as a short-lived annual herb. The flowers are insect pollinated.
- The mucilaginous wing or rim of the seed may be a mechanism for absorbing water to secure germination and coincidentally a dispersal temptation for ants.
- Narrow Goodenia is an annual which appears seasonally and opportunistically in ephemerally damp or wet sitesand is often common at sites after good winter-rainfall periods. It favours moist, shaded, sandy sites, soils with impeded drainage, damp muddy areas of winter inundation, spring-fed paddocks and open areas where water is more available.
- Often found in sites with some form of recent disturbance, such as depressions and clearings made by grading and excavation along roadsides, open grazing land and paddocks inundated by weed species and areas previously cleared and grazed by cattle.
- Associated species at Goobang National Park sites include Eucalyptus blakelyi, Eucalyptus sideroxylon, Eucalyptus bridgesiana, Eucalyptus melliodora, Acacia vestita, Acacia deanei subsp. paucijuga, Acacia penninervis, Acacia mollifolia, Acacia implexa, Callitris endlicheri, Leptospermum divaricatum, Exocarpos strictus, Allocasuarina diminuta subsp. diminuta, Pultenaea foliosa, Hibbertia obtusifolia, Hibbertia riparia, Baeckea cunninghamii and Lomandra longifolia.
- Found to be uncommon and scattered within localised populations recorded in Goobang National Park. The species has been recorded as rare, scattered, locally common and frequent in populations, with the yellow-flowering plants forming a closed carpet in one population.

Regional information: This species is found in the following catchment management authority regions. Click on a region name to see more details about the distribution, vegetation types and habitat preference of the species in that region.

- Border Rivers/Gwydir; Central West; Hunter/Central Rivers; Lachlan; Murray; Namoi; Western

Threats

- Stock grazing, pugging and trampling and pig rooting may damage the swampy habitat of the species.
- The species grows in disturbed sites such as table-drains and along roadsides and is susceptible to road grading, vehicle disturbance and grazing along roadside stock routes.
- Large localised colonies can appear opportunistically after rains in areas of water-collection and in damp soils, and are thus vulnerable to seasonal conditions.

- Competition from exotic weed species is also a threat, particularly competition from other seasonally opportunistic species.

Creeping Tick-Trefoil - *Desmodium campylocaulon*

Conservation status in NSW: Endangered
Description: Prostrate twining herb or erect perennial forb to 1 m high, stems long and stout, covered with hooked hairs. Leaves with 3 leaflets, each lance-shaped, 2-10 cm long and 5-20 mm wide. Flowers pea-like and numerous, pink or bluish, about 6 mm long. Pod saw-like, 15-20 mm long, composed of 3-6 segments, downy when young, membranous and slightly net-veined, swollen when ripe but not splitting at maturity.
Location and habitat
Distribution: Occurs chiefly in the Collarenebri and Moree districts in the north-western plains of NSW. Also occurs in the NT and Darling Downs district of south-eastern Queensland.
Habitat and ecology:

- Creeping Tick-Trefoil is confined to clay soils, usually with Astrebla and Iseilema species.
- In NSW Desmodium campylocaulon grows on cracking black soils in the Narrabri, Moree and Walgett local government areas.
- Associated species include Acacia harpophylla, Astrebla pectinata and Sorghum, Dichanthium and Panicum species.
- Flowers summer and autumn.
- The species is said to be hardy, but grazed where sheep have regular access. Plants are strongly stoloniferous and well-cropped by cattle.
- Plants are recorded as uncommon, occasional, common and frequent in populations.

Regional information: This species is found in the following catchment management authority regions. Click on a region name to see more details about the distribution, vegetation types and habitat preference of the species in that region.

- Border Rivers/Gwydir; Western

Threats

- Grazing (plants are continuously grazed where sheep and cattle have regular access).
- Habitat depletion (the Mitchell Grass areas where the species grows are highly vulnerable to grazing and clearing for cropping).

Desert Cow-Vine - *Ipomoea diamantinensis*

Conservation status in NSW: Endangered
Description: Small hairless annual forb, with thick and hollow trailing stems. Leaves lance-shaped to oblong, 5-15 cm long, 2-8 cm wide, the base blunt or with 2 spreading lobes, the stalk 2-10 cm long. Flowers trumpet-shaped, creamish white, swollen at the top and faintly 5-lobed. Fruit an almost spherical capsule, 9-17 mm in diameter, 2-segmented and usually containing 3 woolly seeds each 6 mm long.
Location and habitat
Distribution: Occurs north from near Goodooga, in the north-western slopes and plains of NSW. Localities include Narran River and Inverell. The species is also found in Qld, the NT, SA and the Kimberley region of WA.
Habitat and ecology:

- Grows on clay soils on floodplains, often in shallow water and mud on cracking grey clay.
- Interstate habitats include low-lying grasslands with scattered Atalaya hemiglauca, Acacia georgensis, gums and boxes, swamp margins and billabongs, a small floodway with Acacia stenophylla, and the water surface of a watercourse with other aquatic plants.
- Associated species include Astrebla squarrosa, Astrebla elymoides, Eremophila bignoniiflora and Muehlenbeckia cunninghamii.
- Flowers mainly summer to autumn.
- Plants recorded as occasional to frequent in populations, with several sites recording only one plant.
- Plants often grow in mud with stems trailing out and over the water. As a prostrate climber, the species can cover areas as large as 10 x 10 m, producing stunning, white-edged, deep-pink throated flowers.

Regional information: This species is found in the following catchment management authority regions. Click on a region name to see more details about the distribution, vegetation types and habitat preference of the species in that region.

- Western

Threats

- Grazing (stock and possibly native herbivores).
- Habitat disturbance (the damp habitats vulnerable to pugging and trampling, clearing, drainage and irrigation).
- Competition from other seasonal annuals may limit the species.

Slender Darling Pea *Swainsona murrayana*

Conservation status in NSW: Vulnerable
National conservation status: Vulnerable
Description: A sparsely-downy forb with greyish, thin or tapered, stiffly leathery pods. The pea-like flowers are pink or purple with red stripes on densely and darkly hairy slender stalks. It is distinguished by the strongly twisted hypanthium and keel with retracted tip.
Location and habitat
Distribution: Found throughout NSW , it has been recorded in the Jerilderie and Deniliquin areas of the southern riverine plain, the Hay plain as far north as Willandra National Park, near Broken Hill and in various localities between Dubbo and Moree.
Habitat and ecology:

- The species has been collected from clay-based soils, ranging from grey, red and brown cracking clays to red-brown earths and loams.
- Grows in a variety of vegetation types including bladder saltbush, black box and grassland communities on level plains, floodplains and depressions and is often found with Maireana species. Plants have been found in remnant native grasslands or grassy woodlands that have been intermittently grazed or cultivated.
- Plants produce winter-spring growth, flower in spring to early summer and then die back after flowering. They re-shoot readily and often carpet the landscape after good cool-season rains.
- The species may require some disturbance and has been known to occur in paddocks that have been moderately grazed or occasionally cultivated.
- Swainsona species contain a poisoning principle, swainsonine, which affects the nervous system and is toxic to stock.

Regional information: This species is found in the following catchment management authority regions. Click on a region name to see more details about the distribution, vegetation types and habitat preference of the species in that region.

- Border Rivers/Gwydir; Central West; Lachlan; Murray; Murrumbidgee; Namoi; Western

Threats

- Heavy grazing by domestic stock, since the species is heavily grazed at most growth stages and is regarded as a useful forage plant (although this may be harmful to stock due to its poisoning effect). Heavy grazing in the flowering and fruiting season in particular, may influence the soil seed bank and hence future abundance of the species on travelling stock reserves and adjoining paddocks.
- Loss of grassland habitat to cultivation, either for pasture improvement or crops, particularly rice crops.
- Invasion of grassland habitat by exotic species due to ploughing or heavy grazing of paddocks, which provides an environment suitable for the invasion of exotic species.
- Increased salinisation, which affects the suitability of habitat.
- Frequent fires may directly affect plants or alter the habitat in which it grows.
- Rabbits and other herbivorous pest species may contribute to the total grazing pressure on this species.
- Urban developments and the expansion of townships into surrounding grasslands has the potential to result in the loss of, or impact on, plants and their habitat.

Cyperus conicus

Conservation status in NSW: Endangered
Description: Tufted, greyish perennial sedge with short thick underground stem. Leaves somewhat rough, 3-5 mm wide. Flowerhead simple or compound with 4-10 branches to 8 cm long, comprising numerous spikelets 2.5-3 mm long and about 0.8 mm wide, pale brown tinged yellow or red-brown. Fruit a triangular black nut, about 1.8 mm long and 0.8 mm diameter.
Location and habitat
Distribution: Occurs rarely in the Pilliga area of NSW and is also found in Victoria, Qld, the NT and WA.
Habitat and ecology:

- Grows in open woodland on sandy soil. In central Australia, the species grows near waterholes and on the banks of streams in sandy soils. In Qld the species usually found on heavy soils.
- Recorded from Callitris forest in the Pilliga area, growing in sandy soil with Cyperus gracilis, C. squarrosus and C. fulvus.
- Interstate habitats include floodplains, creek beds and banks, swamps, run-on areas and various watercourses, near or in dams and bores, and in vegetation communities such as Melaleuca swamps, open Box woodland and sedgelands. Soils are usually sandy or silty and damp to wet.
- Often associated with other sedge species including C. victoriensis, C. difformis, C. iria, C. compressus, C. nervulosus, C. dactylotes, Fimbristylis and Eleocharis species.
- Cyperus conicus has been recorded as very rare and occasional, to common and abundant in populations.

Regional information: This species is found in the following catchment management authority regions. Click on a region name to see more details about the distribution, vegetation types and habitat preference of the species in that region.

- Border Rivers/Gwydir; Namoi

Threats

- Clearing (drainage, irrigation and dredging practices used in cropping and horticulture.
- Changed flooding patterns due to grazing and localised cropping have affected regeneration in some cases.
- Grazing.
- Logging in the Pilliga area.
- Disturbance to the sandy habitat by rabbits.

Narrow-leafed Bumble - *Capparis loranthifolia* var. *loranthifolia*

Conservation status in NSW: Endangered

Description: The Narrow-leafed Bumble is a dense, spiny tree or spreading shrub, 2 - 8 m tall. The bark is dark greyish-brown, narrowly fissured and cracked. The leaves are spirally-arranged, oblong to linear in shape, 3 - 7 cm long and 8 - 10 mm wide. The flowers have cream-coloured petals, each to 20 mm long. Flowers appear singly or in groups up to five, and are on stems 20 - 40 mm long. The fruit is a large, spherical berry, 30 - 40 mm in diameter, smooth or coarsely netted, on a stalk 2 - 9 cm long. The plant is very similar (Capparis mitchellii, but is smaller and more spiny.

Location and habitat

Distribution: Recorded in the north-western plains of NSW, from near Weilmoringle north of Brewarrina. Several populations have recently been found in Culgoa NP. The species is relatively common in western Qld.

Habitat and ecology:

- Throughout its range, found in mixed soft-wood forest in fine red soil, and in brown silty clay-loam near creeks. It is sometimes incorrectly regarded as a weed in cleared areas and is recorded as abundant in the NSW population, and rare and scattered to locally frequent interstate..
- Associated species include Eucalyptus populnea, Eucalyptus melanophloia, Eucalyptus microtheca, Eucalyptus crebra, Geijera parviflora, Acacia aneura, Acacia oswaldii, Acacia harpophylla, Acacia catenulata, Eremophila mitchellii, Atalaya spp. and Triodia spp.
- Plants form low, stunted trees to very bushy, ground-hugging shrubs with a deep green appearance.
- Flowers in spring.

Regional information: This species is found in the following catchment management authority regions. Click on a region name to see more details about the distribution, vegetation types and habitat preference of the species in that region.

- Western

Threats

- Habitat erosion; sandy ridge habitats are vulnerable to degradation from rabbit, stock and goat activities.
- Competition from other woody shrub species may limit distribution and population size.

Maireana lanosa

Status - presumed extinct species listing. Maireana lanosa (Lindley) Paul G. Wilson is listed as Presumed Extinct on the schedules of the NSW Threatened Species Conservation Act. Two major sources were used in deciding to list the species at the introduction of the Threatened Species Conservation Act in 1995:

1. The Rare or Threatened Australian Plants (ROTAP) list

The ROTAP list identifies plants that are at risk nationally. It's the result of research by botanical experts, who started developing the list in 1979. A number of plant species on ROTAP have been listed as vulnerable, endangered or presumed extinct in the NSW Threatened Species Conservation Act.

2. NPWS review of plants across the state

The NPWS developed a draft threatened plant list for NSW, using standardised risk assessment criteria. This project was used to:

- develop the initial plant listings for the NSW Threatened Species Conservation Act
- revise the assessment of several species that had been identified as rare or threatened in ROTAP.

Appendix 3 The Wetlands Database description of the Narran Lake Nature Reserve.

'Criterion 1(a) Narran Lake Nature Reserve is a particularly good representative example of a natural or near- natural wetland characteristic of the Darling Riverine Plains biogeographical region. Narran Lakes contain a considerable diversity of habitats including some of the largest expanses of Lignum (*Muehlenbeckia florulenta*) in NSW which are wetlands are geomorphologically significant as an excellent example of a relatively undisturbed terminal lake system in NSW.

Criterion 2(c) Narran Lake Nature Reserve is of special value as habitat of plants or animals at a critical stage of their biological life cycle Waterfowl which have been recorded breeding in Narran Lake Nature Reserve and which are considered to have a restricted breeding distribution in Western NSW (Smith *et al*, 1995) include: Australian Pelican, Pelecanus conspicillatus, Great Cormorant, Phalacrocorax carbo, Pied Cormorant, Phalacrocorax varius, Darter, Anhinga melanogaster, Rufous Night Heron, Nycticorax caledonicus, Large Egret, Ardea alba, Little Egret, Ardea gazetta, Intermediate Egret, Ardea intermedia, Glossy Ibis, Plegadis falcinellus, Australian White (Sacred) Ibis, Threskiornis molucca, Straw-necked Ibis, Threskiornis spinicollis, Great Crested Grebe, Podiceps cristatus, Royal Spoonbill, Platalea regia, Gull-billed Tern, Sterna nilotica. Narran Lakes are considered to be nationally and internationally significant as they are the major breeding site for the above species of waterbirds and many other species (see Appendix 1 for other species recorded breeding in Narran Lakes area). During the 1994-96 Murray-Darling Basin Water Monitoring Project run by Birds Australia, the Narran wetlands were among the highest ranked sites for species richness, number of breeding species and total number of birds. Narran Lake Nature Reserve also supports a number of internationally important migratory bird species. These species are noted in Appendix 1 as those listed under the Japan-Australia Migratory Bird Agreement (JAMBA) and the China-Australia Migratory Bird Agreement (CAMBA). The Narran Lakes are listed on the Australian Register of National Estate (NPWS, 1995).

Criterion 3(c) Narran Lake Nature Reserve regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl. The large numbers of Black-winged Stilts (*Himantopus himantopus*), Red-necked Avocets (*Recurvirostra novaehollandiae*), Marsh Sandpiper (*Tringa staganatilis*), Straw-necked Ibis (Threskiornis spinicollis) and Red-kneed Dotterel (*Erythrogonys cinctus*) recorded in Narran Lake wetlands suggests that these wetlands may be of international importance for these species (Ley, 1998).'