Methodology Report

Report on the methodology for identifying priority conservation lands on the Cumberland Plain

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Department of Environment, Climate Change and Water NSW
59 Goulburn Street
PO Box A290
Sydney South 1232
Phone: (02) 9995 5000 (switchboard)
Phone: 131 555 (environment information and publications requests)
Phone: 1300 361 967 (national parks information and publications requests)
Fax: (02) 9995 5999
TTY: (02) 9211 4723
Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

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1 Conservation priority assessment of the Cumberland Plain

1.1 Introduction

The Cumberland Plain in western Sydney is one of the most fertile parts of the Sydney Basin and has been extensively cleared for agriculture since European settlement. The remaining vegetation is significantly fragmented and under extraordinary pressure from urban growth. Consequently, the biodiversity of the region has been identified as being amongst the most threatened in NSW.

To inform the preparation of the *Cumberland Plain Recovery Plan* (DECCW 2010), the Department of Environment and Climate Change (DECCW) has undertaken an assessment to identify the lands on the Cumberland Plain that could most effectively be managed for threatened biodiversity. These 'priority conservation lands' represent the best remaining opportunities to secure long-term biodiversity benefits in the region at the lowest possible cost, including the least likelihood of restricting land supply.

The priority conservation lands will be the main focus of future efforts to establish a viable and sustainable protected area[1] network in western Sydney. As DECCW does not have the resources to incorporate all high conservation value lands in the region within its reserve system, it is intended that formal reservation be complemented by voluntary conservation measures on private land and other public land tenures. These measures and other aspects of the proposed recovery program for the threatened biodiversity of the Cumberland Plain are described in DECCW (2010).

This report describes the priority conservation lands and the methods that were used to identify them. These methods included the application of reserve design principles and targets for the inclusion of threatened biodiversity, as well consideration of existing and proposed land uses. The identified priority conservation lands comprise 25,566 ha and are located in seven broad 'candidate areas', that is, Castlereagh, Wilberforce, Mulgoa, Hoxton, Holsworthy, Razorback and Nepean.

1.2 Scope of the assessment

The assessment is based on natural heritage values and identifies the lands that are most suitable for investment in conservation activities. It does not identify all lands in the region with conservation value.

1.2.1 Bioregional and landscape context

The area for this assessment is almost equivalent to the Cumberland subregion within the Sydney Basin bioregion and is referred to as the Cumberland Plain. The Sydney Basin bioregion is one of the most adequately reserved bioregions in Australia. However, the Cumberland subregion is one of the least protected and highly threatened subregions, differing substantially from the well-reserved sandstone landscapes in other parts of the bioregion. The Cumberland Plain was identified as a clear conservation priority in the Landscape Conservation Assessment of the Sydney Basin (DEC 2004).

1.2.2 Consideration of threatened biodiversity

In identifying the priority conservation lands, targets were applied for the inclusion of the threatened species, populations and ecological communities that are endemic or primarily endemic to the Cumberland Plain, and for which a recovery plan has not been prepared[2]. Table 1 shows the threatened biodiversity addressed in the *Cumberland Plain Recovery Plan* (DECCW 2010).

[1] The International Union for Conservation of Nature (IUCN) has developed a categorisation for the most secure reserve types – these are referred to as protected areas. An IUCN protected area is defined as "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means". Further information on the IUCN reserve categories is provided in Appendix 1.

[2] No specific target was applied for the Cumberland Land Snail (*Meridolum corneovirens*) as potential habitat for this species was included in the targets for Cumberland Plain Woodland, Castlereagh Swamp Woodland and River-flat

Table 1. Threatened biodiversity addressed in the *Cumberland Plain Recovery Plan*

Flora species	TSC Act status	EPBC Act status
Allocasuarina glareicola	Endangered	Endangered
Dillwynia tenuifolia	Vulnerable	Vulnerable
Juniper-leaved Grevillea (*Grevillea juniperina* subsp. *juniperina*)	Vulnerable	-
Micromyrtus minutiflora	Endangered	Vulnerable
Sydney Plains Greenhood (*Pterostylis saxicola*)	Endangered	Endangered
Pultenaea parviflora	Endangered	Vulnerable
Fauna species		
Cumberland Land Snail (*Meridolum corneovirens*)	Endangered	-
Populations		
Dillwynia tenuifolia population in the Baulkham Hills LGA	Endangered	-
Dillwynia tenuifolia population at Kemps Creek	Endangered	-
Marsdenia viridiflora R. Br subsp. *viridiflora* population in the Bankstown, Blacktown, Camden, Fairfield, Holroyd, Liverpool and Penrith LGAs	Endangered	-
Pomaderris prunifolia (a shrub) population in the Parramatta, Auburn, Strathfield and Bankstown LGAs	Endangered	-
Ecological communities		
Agnes Banks Woodland	Endangered	-
Castlereagh Swamp Woodland	Endangered	-
Cooks River Castlereagh Ironbark Forest	Endangered	-
Cumberland Plain Woodland (listed on EPBC Act as Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest)	Critically Endangered	Critically Endangered
Moist Shale Woodland	Endangered	-
Shale Gravel Transition Forest (listed on EPBC Act as Cumberland Plain Shale Woodlands and Shale Gravel Transition Forest)	Endangered	Critically Endangered
Shale Sandstone Transition Forest	Endangered	Endangered
River-flat Eucalypt Forest (previously Sydney Coastal River Flat Forest)	Endangered	-
Western Sydney Dry Rainforest	Endangered	-

The following threatened ecological communities (TECs) were not specifically targeted in the assessment, as only a small proportion of their distribution occurs on the Cumberland Plain:

- Blue Gum High Forest in the Sydney Basin Bioregion
- Coastal Saltmarsh in the NSW North Coast, Sydney Basin and South East Corner Bioregions
- Freshwater Wetlands on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner Bioregions

Eucalypt Forest. No targets were applied for Elderslie Banksia Scrub Forest as the future of the remaining 15 ha of this threatened ecological community has been determined through the land use planning system.

- Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner Bioregions and
- Sydney Turpentine Ironbark Forest.

Despite not being specifically targeted, some of these TECs and a broad suite of non-targeted threatened and regionally significant species are present within the priority conservation lands and will benefit from conservation activities within these.

1.2.3 Assumptions and approaches

The area for this assessment is similar to that of the *Native Vegetation of the Cumberland Plain Final Edition* (NPWS 2002). However, the assessment excluded parts of the Hornsby Plateau that were mapped in NPWS (2002).

The assessment used mapped core habitat, as identified in NPWS (2002), as a surrogate for biodiversity and the basic planning unit for the identification of the priority conservation lands. Areas of vegetation identified as having an 'urban understorey'[3] were excluded from consideration in the assessment.

The Cumberland Plain is a highly fragmented landscape with comprehensive information on vegetation communities, but relatively poor data on the regional distribution of fauna. The assessment attempts to incorporate habitat values for threatened fauna species (including the endangered Cumberland Land Snail (*Meridolum corneovirens*)) as well as regionally significant suites of species such as Cumberland Plain woodland birds.

Special consideration in the assessment was given to the threatened flora species and endangered flora populations in Table 1. While comprehensive targeted surveys have not been undertaken for these entities, the number of recent and accurate site records available for them was sufficient to enable their meaningful inclusion in the analysis. Remnant size and condition was used as a surrogate for population viability when prioritising sites that contain these entities for inclusion in the priority conservation lands.

Threat was not considered in the assessment as most of the biodiversity on the Cumberland Plain is threatened by the further loss and degradation of habitat.

1.3 Fragmentation of vegetation on the Cumberland Plain

Habitat loss and fragmentation has been recognised throughout the world as a key issue facing the conservation of biological diversity (IUCN 1980). Human activities have modified natural environments to the extent that the most common landscape patterns are mosaics of human settlements, farmland and scattered fragments of natural vegetation. The Cumberland Plain in western Sydney has been extensively cleared since European settlement with only 13 per cent remaining as intact bushland (NPWS 2002).

1.3.1 Fragmentation analysis - methodology

An analysis of the spatial configuration of remnant vegetation on the Cumberland Plain was undertaken to provide a better understanding of remnant size and distribution, and the distributional patterns of vegetation communities in relation to remnant size.

The fragmentation analysis was undertaken within the boundaries of the Cumberland Plain sub region derived from Interim Biogeographic Regionalisation of Australia (IBRA) Subregions of Australia (Version 5.1). The subregional boundary was used to separate the shale influenced vegetation on the Cumberland Plain from other mapped vegetation such as that on the sandstone of the Hornsby Plateau. Only vegetation mapped in the good condition classes ("A", "B" and "C") of NPWS (2002) was used in the fragmentation analysis, excluding scattered tree condition classes ("TX", "TXR", "TXU" and "X").

[3] "TXU" code in NPWS (2002).

1.3.2 Fragmentation analysis - results

The results of the fragmentation analysis reveal a high degree of fragmentation in the region (Table 2). Some 2,446 individual remnants are present, ranging in size from <1 ha to 3,598 ha. Smaller vegetation remnants are more numerous than larger remnants with 82% of remnants being less than 10 ha in size. While this highlights the region's high fragmentation levels, these remnants account for only 22% of the total remaining vegetation.

Table 2. Cumberland Plain vegetation – fragmentation analysis.

Cumberland Plain vegetation – fragmentation analysis						
Vegetation remnants						
Size class range (ha)	**No. of remnants**	**% of total no. of remnants**	**Cumulative percentage of no. of remnants**	**Area of vegetation (ha)**	**% of total area of vegetation**	**Cumulative percentage of area of vegetation**
<1	465	19	19	218	1	1
>1 <2	476	19	38	712	3	3
>2 <3	332	14	52	829	3	6
>3 <4	222	9	61	773	3	9
>4 <5	155	6	67	695	3	12
>5 <10	364	15	82	2,603	10	22
>10 <25	251	10	93	3,910	14	36
>25 <50	100	4	97	3,554	13	49
>50 <100	47	2	99	3,260	12	61
>100 <200	18	1	99	2,437	9	70
>200 <500	13	1	100	3,358	12	83
>500	3	0	100	4,728	17	100
Total	**2446**	**100**	**100**	**27,077**	**100**	**100**

The analysis shows that while only 13% of the natural vegetation of the region remains intact, over half (51%) lies within remnants that are greater than 50 ha in size. These larger remnants would be more likely to maintain biodiversity values into the future subject to appropriate management. Encouragingly, over one third (38%) of the remaining vegetation occurs in remnants between 100 ha and 500 ha in size. However, only 60% of the vegetation in these size classes consists of TECs, and 51% of the vegetation in the largest size class (>500 ha) is Castlereagh Scribbly Gum Woodland which is not listed as a TEC.

1.3.3 Vegetation community fragmentation analysis

In addition to the basic fragmentation analysis, which was completed without regard to vegetation type, a more detailed analysis of the fragmentation level of each vegetation community and TEC was also completed.

This analysis showed that for the following TECs, over one quarter of their extant distribution is in remnants less that 10 ha in size:

- Cumberland Plain Woodland – 29.5%
- River-flat Eucalypt Forest on Coastal Floodplains – 25%
- Sydney Turpentine Ironbark Forest – 55% and

- Elderslie Banksia Scrub Forest – 31%.

The results also showed that of the 19 vegetation communities within the fragmentation analysis, the following 12 communities have greater than half of their extant distribution in remnants less than 50 ha in size:

- Shale Sandstone Transition Forest (Low Shale Influence) – 70.8%
- Shale Sandstone Transition Forest (High Shale Influence) – 56.9%
- Cumberland Plain Woodland Vegetation (Shale Plains Woodland) – 56.8%
- Cumberland Plain Woodland (Shale Hills Woodland) – 54.9%
- River-flat Eucalypt Forest on Coastal Floodplains (Alluvial Woodland) – 63.4%
- River-flat Eucalypt Forest on Coastal Floodplains (Riparian Forest) – 73.8%
- Sydney Turpentine Ironbark Forest (Turpentine–Ironbark Forest) – 100%
- Sydney Turpentine Ironbark Forest (Turpentine–Ironbark Margin Forest) – 100%
- Western Sydney Dry Rainforest – 64.1%
- Cooks River Castlereagh Ironbark Forest – 50.3%
- Elderslie Banksia Scrub Forest – 58.6% and
- Sandstone Ridgetop Woodland (non-TEC) – 79%.

1.4 Conservation targets used in this assessment

The national criteria generally applied for the conservation of forest biodiversity in Australia are known as the Comprehensive, Adequate and Representative (CAR) criteria (Commonwealth of Australia 1992). These criteria include, as a general principle, that 15% of the pre-1750 extent of each forest ecosystem, 60% of the extant area of each vulnerable ecosystem, and all remaining rare and endangered ecosystems be included in a CAR reserve system, with flexibility applied according to regional situations. These criteria are guidelines rather than mandatory targets, designed to deliver good conservation results as well as acceptable social and economic outcomes.

The *NSW Reserve Establishment Plan* (DECCW 2008), while being based on the conservation planning principles of CAR, recognises the extent to which broad scale habitat loss is acting to permanently limit the opportunities for establishing large or moderately sized reserve systems in many regions such as the Cumberland Plain.

The Cumberland Plain is a highly fragmented landscape and many of the vegetation communities present have been cleared to well below 15% of their pre-1750 extent. The establishment of conservation targets in the region is a complex issue, particularly due to competing land uses, high land values and management costs, and the continued threat of further clearing and fragmentation. A summary of the revised CAR targets for western Sydney is provided in Appendix 2.

In recognition of the above issues, this assessment has set a minimum target of 15% of the existing area of each of the TECs in Table 1 for inclusion within the priority conservation lands. This is equivalent to at least 5% of the pre-1750 distribution of these TECs. The assessment has also set minimum targets for the inclusion of the threatened flora species and endangered populations listed in Table 1 within the priority conservation lands (Table 3).

Table 3. Targets for selected threatened flora species and endangered flora populations

No. of extant populations[4]	Target for inclusion within priority conservation lands[5]
1 to 6	100%
7 to 20	80%
>20	60%

The above targets do not represent thresholds which, if passed, indicate "recovery" of the relevant threatened entities. The targets were applied to assist in identifying the best remaining opportunities to secure long-term biodiversity benefits in the region and, in doing so, provide a practical and realistic focus for recovery efforts associated with the *Cumberland Plain Recovery Plan* (DECCW 2010).

2 Assessment methodology

2.1 Methodology for identifying priority conservation lands

There are generally two main considerations when assessing the potential of an area for formal reservation or other conservation mechanism: capability and suitability.

In this study, capability was assessed in relation to biodiversity values and viability. The capability assessment focussed on identifying the lands with the greatest potential to deliver long-term conservation outcomes for the study's targeted threatened biodiversity. This involved prioritising the most viable habitats for each threatened entity for inclusion in the priority conservation lands, as well as ensuring that representation targets for each of these were met.

The consideration of viability included intrinsic factors and landscape considerations. Intrinsic factors included size and shape, current condition and the prognosis for recovery or further deterioration. At the landscape level, the key consideration was the extent of connectivity or vegetation linkages which facilitate the movement of flora and fauna and thereby contribute to available habitat.

The suitability assessment determined which areas identified in the capability assessment were the most cost-effective for conservation management. This involved consideration of socio-economic factors including potential management costs and proposed land use.

It is important to note that although the assessment may have determined that an area is a priority for conservation activities in its current state, this may cease to be the case if, for example, the vegetation becomes fragmented or is impacted by nearby development.

2.1.1 Capability assessment: identifying regional clusters

The initial stage of the capability assessment involved using a GIS mapping program to select all areas of core habitat identified in the Cumberland Plain vegetation mapping (NPWS 2002) that were at least 50 ha in size and within 500 m of selected records of threatened fauna and flora. The 50 ha size threshold was applied in the first instance with the aim of identifying the largest remnants of vegetation remaining on the Cumberland Plain.

There is a wealth of scientific literature relating to patch size analysis that recognises that larger patches of vegetation are more likely to retain their biodiversity values over time (eg. Rothley *et al* 2004, Bennett 1999, IUCN 1994). Recent work in Australia suggests 50 ha as being a "core" area of vegetation or habitat (Parkes *et al* 2003) and patches less than 50 ha being classified as small patches that are more susceptible to a decline in biodiversity values over time (CARSAG 2004).

[4] Delineated by geographic discontinuities of >1 km between reliable records.

[5] Where a population comprised more than one site (delineated by geographic discontinuities of >200 m between reliable records), the population was considered to be within the priority conservation lands if 50% or more of the sites for that population were located within the priority conservation lands.

Consideration of significant species of flora and fauna is a common consideration when identifying areas of high conservation priority, so sites in proximity to priority flora and fauna records were selected. The 500 m distance threshold was applied to account for errors in database record location as there was insufficient time available to spatially validate these data.

Threatened fauna records were selected from the NSW Wildlife Atlas database with records of bats, waterbirds and very mobile birds such as large forest owls being removed. Typical Cumberland Plain woodland birds were identified using the *Urban Bushland Biodiversity Survey of Western Sydney* (NPWS 1997). Records of both flora and fauna classified as inaccurate and those older than 20 years were not included.

A buffer of 250 m was used, as a visual aid only, around the selected fragments of core habitat to assist in grouping the fragments into regional clusters according to their affinities in location, landform, vegetation communities and land use. This assisted in ensuring that TECs were included across their geographical range. Core habitat outside the major clusters was not considered any further.

Seven regional clusters were identified in this stage of the analysis. These were named Castlereagh, Wilberforce, Mulgoa, Hoxton, Holsworthy, Razorback and Nepean.

The location of the seven regional clusters is shown in Map 1.

2.1.2 Initial suitability assessment

The initial stage of the suitability assessment involved removing the 250 m buffer, as well as built-up areas and areas that would obviously not meet general reserve design principles (e.g. long, narrow strips of vegetation along creek lines). The boundaries of each cluster were then modified to:

- incorporate existing DECCW managed reserves, as well as existing reserve proposals and commitments and
- exclude areas identified for future urban growth, including the certified areas of the North West and South West Growth Centres and properties zoned for residential[6] or industrial uses.

2.1.3 Capability assessment: meeting TEC targets

In this stage of the capability assessment a unique site number was assigned to each remnant within the regional clusters. This enabled the potential contribution of each remnant towards the TEC targets to be determined.

The baseline target was to incorporate at least 15% of the extant area of each TEC within the priority conservation lands. Where more than one vegetation community was described for a particular TEC (e.g. the Cumberland Plain Woodland TEC includes two separately mapped vegetation communities), the 15% target was applied to each community. Isolated fragments of vegetation were excluded if they were not considered to contain a relatively significant proportion of TECs. This significance was assessed as outlined in Figure 1.

In order to meet the 15% target, the contribution that each site could make towards the reservation of a TEC was considered. For each TEC, sites were selected from the remnant that contained the largest area in decreasing order until the 15% target was reached. This process was undertaken for each TEC until the minimum number of sites had been selected to meet the15% target.

An additional area was subsequently identified near Bargo. This area was not identified in the initial analysis as much of its vegetation was ‘unclassified’ in the mapping and therefore not identified as a TEC. Limited ground-truthing has confirmed that much of this unclassified vegetation is Shale Sandstone Transition Forest. Consequently, the priority conservation lands in the Nepean region were extended to incorporate contiguous intact vegetation in this area.

[6] Rural residential zonings were not excluded.

2.1.4 Capability assessment: meeting threatened flora targets

Once the TEC targets had been met, a desk-top analysis was undertaken to determine the extent to which populations of each of the threatened flora species and endangered populations listed in Table 1 were represented within the priority conservation lands. This analysis was based primarily on post-1985 wildlife atlas records with a minimum accuracy of 100 metres. Less accurate records were used where the site description enabled a location to be determined to within a specific vegetation remnant. Additional (non-wildlife atlas) site records from DECCW files and other reports were used where available.

If the target percentage (as specified in Table 3) for the inclusion of populations within the priority lands was not met for a specific threatened species or endangered population, then additional sites were added to the priority lands until the target was reached. These additional sites were prioritised for inclusion based on the size and condition of the remnant vegetation that was present.

2.1.5 Final suitability assessment

The final stage of the suitability assessment involved using remote imagery[7] to detect recent vegetation disturbances, and identify potential management problems. Site inspections to ground-truth vegetation condition were undertaken at selected sites where access was permitted. Highly disturbed sites were removed from the priority conservation lands if they were considered not to contribute substantially to the viability of a larger remnant.

The final boundaries of the priority conservation lands are shown on Map 2.

2.2 Local scale corridors

This assessment focussed on identifying vegetation remnants with the greatest potential to deliver long-term conservation outcomes for selected threatened biodiversity on the Cumberland Plain. DECCW acknowledges the important work that is being undertaken in several local government areas to protect and enhance local riparian corridors and other ecological linkages, such as stepping-stone reserves. That work, in coordination with appropriate planning controls, will potentially provide a valuable compliment to the priority conservation lands and will assist in conserving biodiversity more generally.

[7] 2007 SKM aerial photography was used where available; 2005 SPOT imagery was used in other areas.

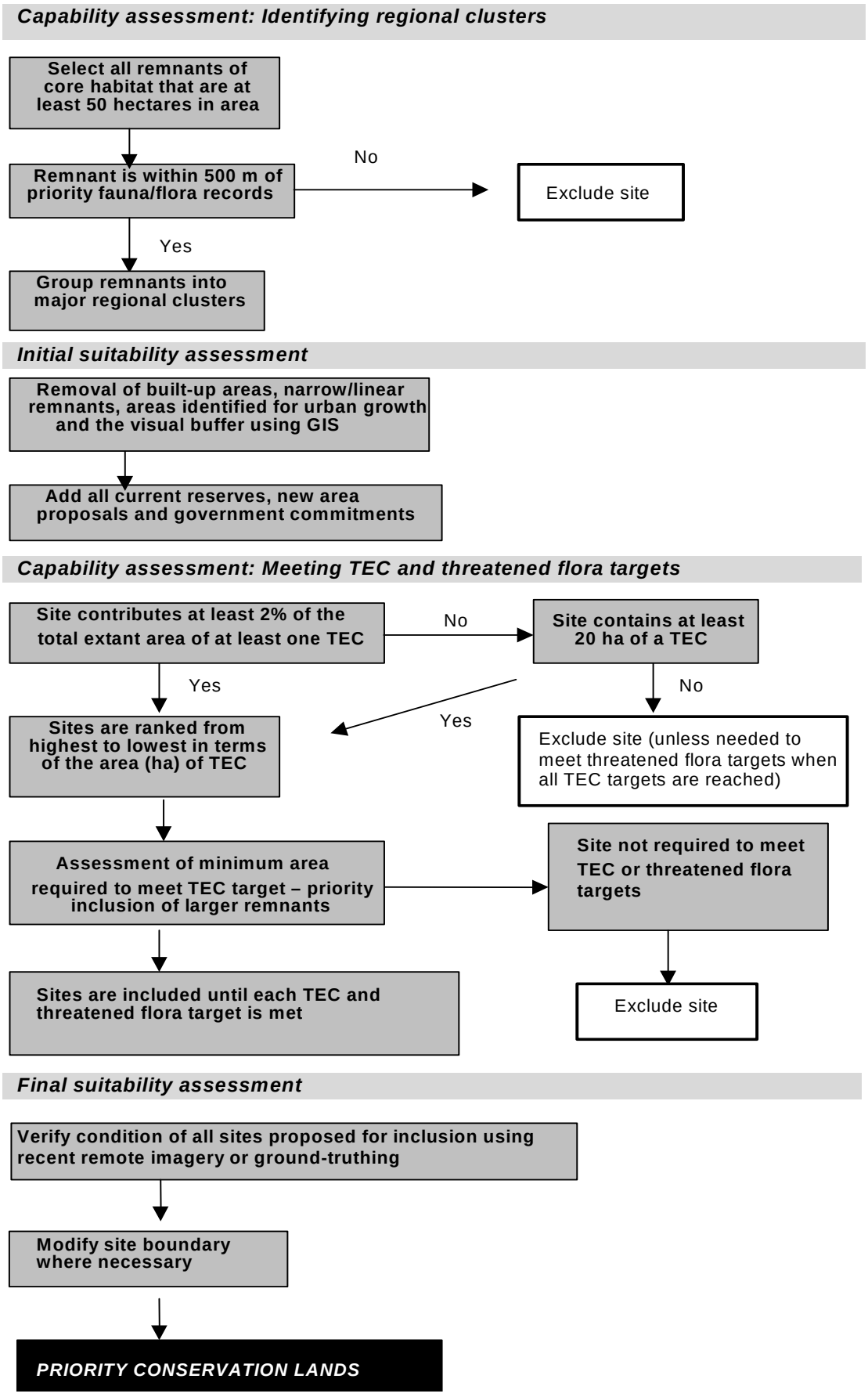
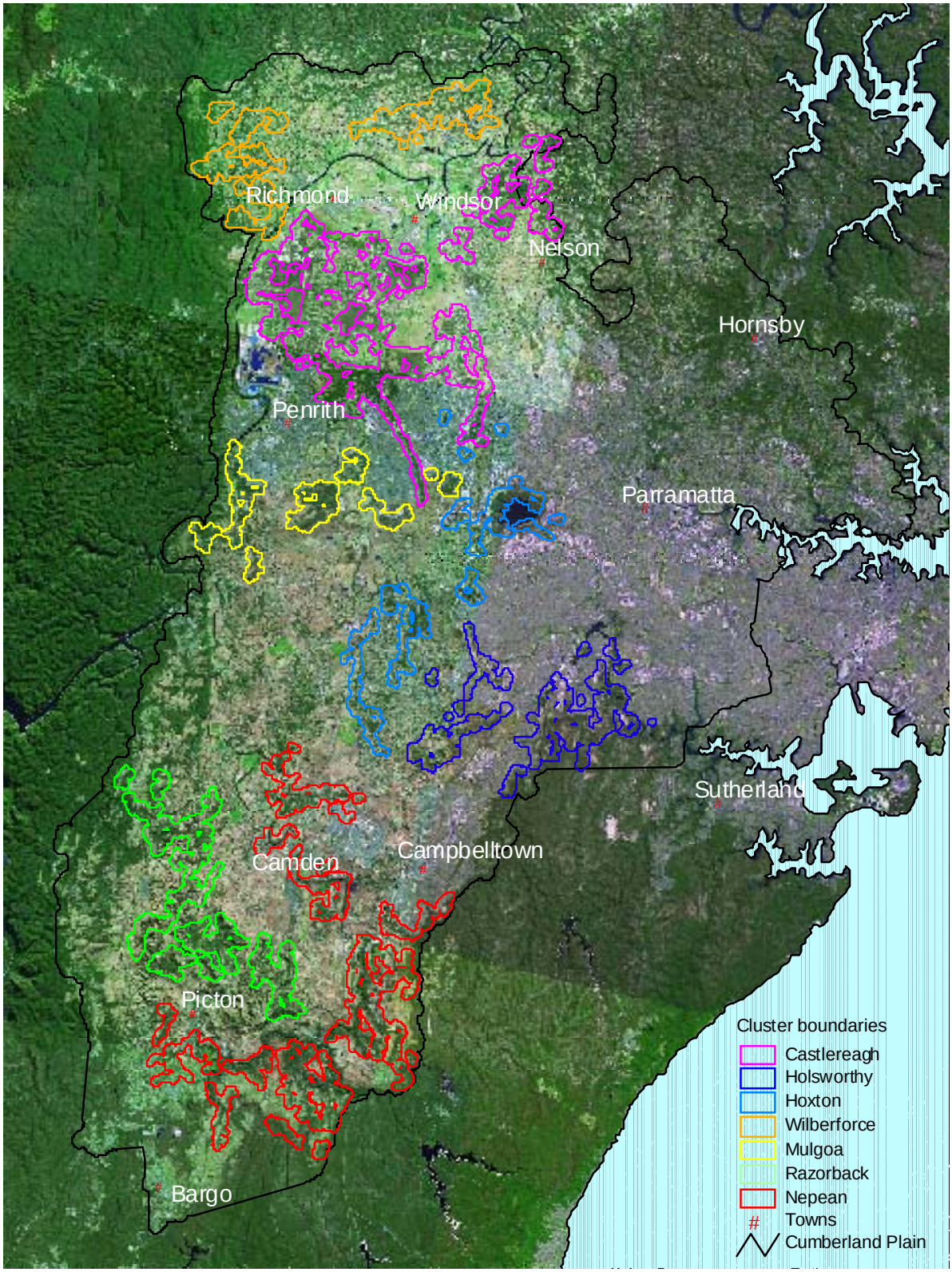
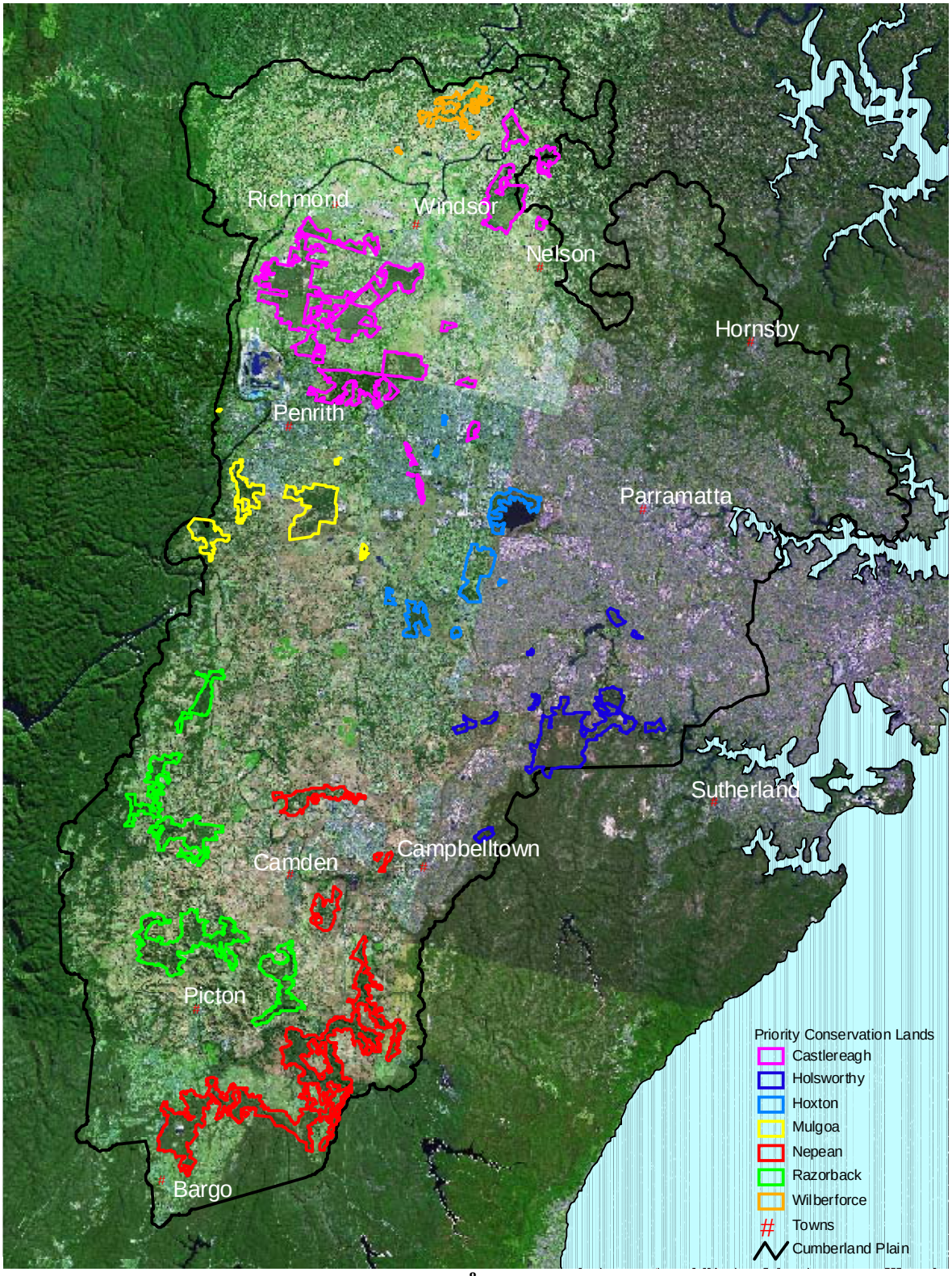


Figure 1. Representation of decision making used to assign sites to the priority conservation lands



Map 1. Original cluster boundaries



Map 2. Final priority conservation lands[8]

[8] ArcGIS shapefiles of the priority conservation lands are available on the DECCW website at www.maps.environment.nsw.gov.au/.

3 Results of the assessment

3.1 Threatened biodiversity

Approximately 14,499 ha of the priority conservation lands contain the targeted TECs (Table 5). The representation target of 15% of current extent was met for all nine of these TECs, and all are well over this target. All of the threatened flora species and endangered populations that were included in the assessment met their representation targets, with the exception of the *Pomaderris prunifolia* endangered population[9] (Table 4)

The priority conservation lands contain 6,923 ha of "other" native vegetation, including non-targeted TECs, non-threatened vegetation and unclassified vegetation. "Other" native vegetation was included in the priority conservation lands when it occurred at a site that was selected to meet a threatened flora target, or when it formed part of a larger remnant that was selected to meet a TEC target.

Table 4. Results of assessment for threatened flora species and endangered flora populations

Threatened flora species	Populations on the Cumberland Plain	Populations within the priority lands	Actual proportion	Target proportion
Allocasuarina glareicola	5	5	100%	100%
Dillwynia tenuifolia	28	20	71%	60%
Grevillea juniperina subsp. *juniperina*	27	17	63%	60%
Micromyrtus minutiflora	11	10	91%	80%
Pterostylis saxicola	6	6	100%	100%
Pultenaea parviflora	30	19	63%	60%
Endangered flora populations	**Populations on the Cumberland Plain**	**Populations within the priority lands**	**Actual proportion**	**Target proportion**
Dillwynia tenuifolia (Kemps Creek)	1	1	100%	100%
Dillwynia tenuifolia[10] (Baulkham Hills)	1	1	100%	100%
Marsdenia viridiflora	10	8	80%	80%
Pomaderris prunifolia[11]	2	1	50%	100%

[9] One of the two remaining naturally occurring sites for this endangered population (at Rydlemere) is zoned for industrial uses and consequently is not eligible for inclusion in the priority lands. It is proposed that specific actions for the in-situ management of this small road-site site be included in the recovery plan along with consideration of a translocation program.

[10] An additional site for this endangered population on Wisemans Ferry Rd occurs outside the Cumberland Plain and so was not included in this assessment.

[11] A translocation recipient site for this species in Rookwood Cemetery was not included in the assessment as it is not naturally occurring.

Table 5. Results of assessment for TECs

Extent[12]	Current area total (ha)		Area on DECCW estate (ha)	Area on DECCW estate (%)	Area in priority lands (ha)	Area in priority lands (%)
Condition classes[13]	A, B and C	TX and TXR	A, B and C	A, B and C	A, B and C	A, B and C
TEC – *Vegetation community*						
Agnes Banks Woodland	88	86	38	43	73	83
Castlereagh Swamp Woodland	609	42	115	19	557	91
Cooks River Castlereagh Ironbark Forest	976	407	336	34	708	73
Moist Shale Woodland	603	543	6	1	478	79
Western Sydney Dry Rainforest	335	232	<1	<1	206	61
Shale Gravel Transition Forest	1,670	1,242	229	14	1,077	64
Cumberland Plain Woodland (Shale Hills Woodland)	4,206	5,650	325	8	1,830	44
Cumberland Plain Woodland (Shale Plains Woodland)	6,406	8,268	642	10	2,341	37
Total for CPW	**10,612**	**13,918**	**967**	**9**	**4,171**	**39**
Shale Sandstone Transition Forest (Low Sandstone Influence)	1,215	1,620	16	1	362	30
Shale Sandstone Transition Forest (High Sandstone Influence)	8,427	6,313	404	5	2,783	33
Total for SSTF	**9,642**	**7,933**	**420**	**4**	**3,145**	**33**
River-flat Eucalypt Forest on Coastal Floodplains (Alluvial Woodland)[14]	4,613	3,485	107	2	1,117	24
River-flat Eucalypt Forest on Coastal Floodplains (Riparian Forest)	700	431	5	1	222	32
Total for RFEF	**5,313**	**3,916**	**112**	**2**	**1,339**	**25**
Grand total	**29,850**	**28,319**	**2,242**	**8**	**11,754**	**39**

[12] Within the NPWS (2002) study area. Some communities extend beyond the study area and so have a greater total extent.
[13] As mapped by NPWS (2002) and Tozer (2003). Figures for "A", "B" and "C" condition classes include mapping by the NSW Scientific Committee and Simpson (2008) for Cumberland Plain Woodland plus addition mapping performed for the other TECs.
[14] Figures for Alluvial Woodland may include some areas of the Swamp Oak Floodplain Forest TEC.

3.2 Non-vegetated areas

There is no mapped native vegetation in 4,145 ha of the priority conservation lands. These areas comprise:

- extensive areas of' "derived" native grasslands[15] which were not identified in NPWS (2002) but which link mapped TEC remnants, including at the Cranebrook and Orchard Hills sites
- non-vegetated parts of the DECCW estate, including parts of Scheyville National Park
- roads and rivers
- small cleared areas on the boundary of the priority conservation lands that were included to establish sensible management boundaries and
- small cleared areas within large vegetation remnants, some of which contain houses or infrastructure.

3.3 Tenure and zoning

The priority conservation lands cover a wide range of land use zones (Table 6). In identifying the priority conservation lands efforts have been made to avoid lands which are subject to zonings that are particularly hostile to conservation values such as residential and industrial.

Table 6. Land use zoning in the priority conservation lands

Zoning	Area (ha)	Proportion
Environmental Protection[16]	2,333	9%
National Park	3,474	14%
Open Space[17]	2,060	8%
Other[18]	268	<1%
Rural[19]	11,715	46%
Special Uses	4,627	18%
Subject to condition 12 of GCBCO[20]	1,089	4%
Total	**25,566**	

The priority conservation lands cover a range of different land tenures (Table 7). Almost 4,000 hectares is already contained within conservation reserves. The large areas of Crown and Commonwealth land are the most likely candidates for further reservation. More than half of the land identified is freehold land and these areas are more likely to be targeted for voluntary conservation covenants and Biobanking agreements.

[15] Areas with a relatively intact native understorey but with canopy species missing due to disturbance
[16] The Environmental Protection (Eco-residential) zone of Camden Council is included within this category
[17] Includes over 1000 ha within Western Sydney Parklands which is subject to State Environmental Planning Policy 31 (Regional Parklands), including lands within Prospect Nature Reserve, Western Sydney Regional Park and Kemps Creek Nature Reserve
[18] Includes rivers, roads and other unzoned areas, as well as proposed roads and lands reserved for other purposes, including open space
[19] Including rural residential zones
[20] Land marked with red hatching on the maps accompanying the Growth Centres biodiversity certification order (NSW Government 2007) where the native vegetation will be retained pursuant to condition 12 of the order

Table 7. Tenure in the priority conservation lands

Tenure	Area (ha)	Proportion
Australian government	3,602	14%
Council	242	<1%
Crown	1,732	7%
Freehold	14,887	58%
National Park	3,973	16%
Other State government	1,130	4%
Total	**25,566**	

4 Priority conservation lands: a quick snap shot

Castlereagh priority conservation lands

The Castlereagh lands have a total area of approx 7,514 ha including the largest intact area of vegetation remaining on the Cumberland Plain. They predominantly contain Castlereagh Scribbly Gum Woodland (not listed as endangered) and Cumberland Plain Woodland with significant areas of Cooks River Castlereagh Ironbark Forest, Shale Gravel Transition Forest and Castlereagh Swamp Woodlands also present. The Castlereagh lands are particularly important for threatened flora species including *Allocasuarina glareicola, Dillwynia tenuifolia,* Juniper-leaved Grevillea *(Grevillea juniperina subsp. juniperina), Micromyrtus minutiflora* and *Pultenaea parviflora*. DECCW, Department of Lands and Air Services Australia are the principal public landholders, while the University of Western Sydney and the John Maroney Correctional Centre also manage significant areas. About 45% of the Castlereagh lands are privately owned and zoned rural. The Castlereagh lands are a priority for future reservation, complemented by voluntary Biobanking agreements and conservation covenants.

Holsworthy priority conservation lands

The Holsworthy lands cover approximately 2,801 ha in the vicinity of the suburb of Holsworthy. Much of the vegetation on these lands is in extremely good condition and the Department of Defence is the principal public landholder. The Holsworthy lands are made up of a mix of shale, transition and sandstone communities and contain five of only six known sites for the threatened Sydney Plains Greenhood (*Pterostylis saxicola*). A conservation plan with the Department of Defence would be a priority for the Holsworthy lands. There is also some scope for reserve additions to the existing Georges River National Park.

Hoxton priority conservation lands

The Hoxton lands have a total area of over 1,172 ha and, while containing some good stands of remnant vegetation, contain some of the more fragmented priority conservation lands. The Hoxton lands consist mostly of Cumberland Plain Woodland and River-flat Eucalypt Forest with patches of Shale Gravel Transition Forest and Cooks River Castlereagh Ironbark Forest near Kemps Creek. Most of these lands are within the Western Sydney Parklands although some significant stands of remnant vegetation lie outside this boundary. The Western Sydney Parklands Trust will be an important manager of conservation values within the Parklands as well as a significant provider of open space.

Mulgoa priority conservation lands

The Mulgoa lands have a total area of 2,061 ha and are located around the suburbs of Mulgoa and Orchard Hills. The remnant vegetation on these lands consists mainly of Cumberland Plain Woodlands with significant areas of Shale Sandstone Transition Forest and River-flat Eucalypt Forest also present. The Department of Defence land at Orchard Hills makes up 54% of the Mulgoa lands, while DECCW is the only other major public landholder present (Mulgoa Nature Reserve). The remaining lands are mostly privately owned and zoned for rural land uses. The Orchard Hills site is particularly significant due to the extremely low historical disturbance levels within vegetated areas, the presence of a number of nationally listed threatened bird species, and the high possibility of successful regeneration of 'cleared' lands on site. Formal reservation of the majority of the Australian Government owned Orchard Hills land is the priority for the Mulgoa lands with other possible reserve additions to the south of the existing nature reserve.

Nepean priority conservation lands

The Nepean lands cover approximately 6,551 ha and extend along parts of the Nepean River from Appin to Menangle and Bargo. These lands are connected beyond the Cumberland Plain to the southern water catchments. Their remnant vegetation is a combination of shale, transition and sandstone communities with significant areas of River-flat Eucalypt Forest. These lands have particularly significant fauna values, especially for woodland birds, and contain large good-condition remnants of Shale Sandstone Transition Forest. The majority of the Nepean lands are privately owned apart from some Crown land in the south and the northern tip of Upper Nepean State Conservation Area. The majority of the private lands are zoned for rural land uses or environmental protection. Conservation of the Nepean lands will most likely depend primarily on voluntary Biobanking agreements and conservation covenants, although there may be limited reservation opportunities.

Razorback priority conservation lands

The Razorback lands cover approximately 4,813 ha and extend along the Razorback Range to the north and west of Picton and Camden. This area is dominated by Cumberland Plain Woodland with significant areas of Moist Shale Woodland and Western Sydney Dry Rainforest. The southern Razorback lands are almost entirely freehold while the northern section contains Gulguer Nature Reserve and Bents Basin State Conservation Area. About two thirds of these lands are zoned rural with the remainder zoned for environmental protection or water catchment. It is estimated that there are about 350 individual privately owned lots in a mix of large rural lots and smaller rural residential lots. Conservation of the Razorback lands will depend primarily on voluntary Biobanking agreements and conservation covenants.

Wilberforce priority conservation lands

The Wilberforce lands are the smallest and most disturbed group of priority conservation lands, covering 653 ha. These lands were selected largely due to the presence of large stands of River-flat Eucalypt Forest (Alluvial Woodlands) There are no DECCW-managed lands present. The majority of the Wilberforce lands are freehold and zoned for environmental protection, so conservation will depend primarily on voluntary Biobanking agreements and conservation covenants.

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Appendix 1. IUCN protected area categories

The International Union for Conservation of Nature (IUCN), a coalition of states, government organisations, non-government organisations, scientists and experts from around the world, has developed a categorisation for the most secure reserve types (referred to as Protected Areas) as a standardised way of comparing and reporting on various reservation programs worldwide. The Collaborative Australian Protected Areas Database (CAPAD) is a national database containing information on all such declared Protected Areas in Australia. It is a textual and spatial database.

As part of formal agreements with the Australian Government, the NSW Government, along with all other states and territories, has agreed to provide the Australian Government with periodic updated listings on the categorisation of all its reserves. This is to enable the Australian Government to regularly update CAPAD in order to monitor and report reservation progress nationally and internationally.

An IUCN Protected Area is defined as "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means." There are 6 Protected Area Management categories that reflect varying levels of reservation security, use and management intent (IUCN 1994).

An important use of the IUCN Protected Area categorisation is the setting of baseline standards for reserve system planning and establishment. For example, the Regional Forest Agreements used the IUCN categories I-IV as their minimum standard for developing a forest reserve system. Any reserve type not meeting this standard of reserve security did not qualify as a 'reserve' under the Regional Forest Agreement process. In addition, the Australian Government specifies Categories I-VI to define what constitutes the National Reserve System (NRS), as reported in CAPAD, and Categories I-IV as the target for its National Reserve System Program.

The tagging of a Parks Service reserve with a IUCN category places no additional obligations on how Parks Service manages its reserves. The categorisation of an Investigation Area will be used to inform future reserve managers of the original intended purpose of the new reserve at the time of investigation and provide a starting point for reviewing the IUCN category following reservation and when management planning commences.

Consideration of the values and subsequent management plan for the area needs to be given when assigning an IUCN category. For example, the IUCN protected area management category definition for Nature Reserve and Wilderness Area recognises natural values rather than cultural values. Thus, if a Parks Service nature reserve with significant cultural values has an IUCN Ia Strict Nature Reserve categorisation, the attachment to and use of these areas by contemporary communities is unlikely to be recognised. Whereas, an IUCN II National Park category does recognise cultural values and opportunities.

Category	Definition
Ia: Strict Nature Reserve: Protected Area managed mainly for science.	Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.
Ib: Wilderness Area: Protected Area managed mainly for wilderness protection.	Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.
II: National Park: Protected Area managed mainly for ecosystem protection and recreation.	Natural area of land and/or sea, designated to: a) protect the ecological integrity of one or more ecosystems for present and future generations b) exclude exploitation or occupation inimical to the purposes of designation of the area and c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
III: Natural Monument: Protected Area managed mainly for	Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic

Category	Definition
conservation of specific natural features.	qualities or cultural significance.
IV : Habitat/Species Management Area: Protected Area managed mainly for conservation through management intervention.	Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
V : Protected Landscape/Seascape: Protected Area managed mainly for landscape/seascape conservation and recreation.	Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.
VI : Managed Resource Protected Area: Protected Area managed mainly for the sustainable use of natural ecosystems.	Area containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.
UA: Unassigned	Where the site does not meet the internationally recognised definition of a Protected Area, application of a management category is not appropriate. This is indicated as category unassigned ("UA") in World Conservation Monitoring Centre protected area lists.

Appendix 2. Principles of a CAR reserve system applied to western Sydney

The establishment of reserves is a key element of government policy. At the national level the goal of a "Comprehensive, Adequate and Representative System of Reserves" for Australia is endorsed by the Commonwealth, State and Territory Governments, as signatories to the *National Strategy for Conservation of Australia's Biological Diversity*[21] and the *National Forest Policy Statement* (Commonwealth of Australia 1992). Successive State and Australian governments have collaborated on three processes to work towards a comprehensive, adequate and representative (CAR) system of protected areas – the National Reserve System, the Regional Forest Agreements and the National Representative System of Marine Protected Areas.

At a state level, the *NSW Biodiversity Strategy* (NSW Government 1999), State Government's Action for the Environment Policy Statement and the *DECCW Corporate Plan*[22] all reflect the NSW State Government's commitment to the development of a CAR reserve system for all parts of NSW.

In western Sydney, DECCW will seek to establish a protected area network which meets the following criteria. The protected area network will comprise formal reserves complemented by other public and private lands where secure agreements are in place to achieve biodiversity conservation.

Comprehensiveness: the National Reserve System (NRS) aims to include the full range of regional ecosystems recognised at an appropriate scale within and across each IBRA region. The planning units used for western Sydney are TECs. The target for comprehensiveness across western Sydney is to sample each TEC within the protected area network.

Adequacy: the target is to protect each type of TEC to the level necessary to provide ecological viability and integrity. The target for western Sydney is to include, at a minimum, 15% of the current extent of each TEC on the Cumberland Plain within the protected area network. The most viable remaining stands for each TEC have been identified and are a priority for inclusion in the protected area network.

Representativeness: the target is to include each type of TEC within each IBRA subregion within the protected area network. The Cumberland Plain approximately represents a single subregion, Cumberland, and thus the target for representativeness is equivalent to the target for comprehensiveness, that is, to sample each TEC within the reserve system.

[21] For more information see www.environment.gov.au/biodiversity/publications/strategy/chap1.html.
[22] For more information see www.environment.nsw.gov.au/whoweare/plan.htm.