Banksia Woodland Restoration Project

Site Selection for Topsoil Transfer and Management Actions

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Cover images: Top to bottom, left to right - Menzies banksia (*Banksia menziesii*) in flower only three years after planting on the Anketell Rd restoration site; Carnaby's cockatoos (*Calyptorhynchus latirostris*) on candle banksia (*Banksia attenuata*); the grand spider orchid (*Caladenia huegelii*). Photos by Mark Brundrett

Abbreviations and Definitions

- BWR – Banksia Woodland Restoration Project (this project)
- CBC - Carnaby's cockatoo (*Calyptorhynchus latirostris*)
- DEC – the former Department of Environment and Conservation, now the Department of Biodiversity, Conservation and Attractions
- Delphi Review - review of information by experts with knowledge and experience in the appropriate subject/s.
- DEWHA – the former Commonwealth Department of the Environment, Water, Heritage and the Arts, now the Department of the Environment.
- EPBC – *Environmental Protection and Biodiversity Conservation Act* 1999
- JAH – Jandakot Airport Holdings Pty Ltd
- Restoration – in this report refers to creating new habitat by establishing a specific type of native vegetation in totally cleared areas within the conservation estate. More generally, Ecosystem Restoration is the "process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (SER Primer, 2004).
- Rehabilitation – in this report refers to controlling threatening processes in existing native habitat to improve condition (e.g. weed control, access control).
- SCP – Swan Coastal Plain
- SEWPAC - the former Commonwealth Department of Sustainability, Environment, Water, Population and Communities, now the Department of the Environment.
- TEC - Threatened Ecological Community

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Executive Summary

This report summarizes the approaches used to develop a ranking process that was used to select sites for restoration by the Banksia Woodland Restoration Project. Restoration sites were chosen after ranking all Bush Forever sites according to a comprehensive set of selection criteria that focused on biodiversity conservation values and similarity to the Jandakot Airport banksia woodland. For restoration using topsoil, two large open sites in Jandakot Regional Park and at Forrestdale Lake were selected. The ranking system was also modified to help select areas for other management actions such as weed control and fencing. The ranking systems used were designed to identify significant areas of banksia woodland, particularly those used as feeding sites for Carnaby's black cockatoos, to compensate for habitat loss due to land clearing at Jandakot Airport. The site ranking process also gave preference to large areas of bushland similar to Jandakot Airport, habitats for the threatened grand spider orchid (*Caladenia huegelii*) and other key indicators of the conservation value of Bush Forever sites. This ranking process proved an effective desktop tool used to guide initial site selection for restoration and rehabilitation of banksia woodland. Final site selection relied on site-specific knowledge provided by departmental staff, on ground site inspections and the practical operational requirements of the various activities that needed to be taken for topsoil transfer and management actions.

Three phases were undertaken in the site selection process, first a desktop review and ranking of conservation values for sites with some existing protection, then second a limited desktop review of threats, and finally an iterative Delphi review process of threats and management issues for the most highly ranked sites, including on ground assessments as required.

Introduction

In March 2010, the Commonwealth Government granted conditional approval for the clearing of 167 hectares of native vegetation at Jandakot Airport (Figure 1). The *Environmental Protection and Biodiversity Conservation (EPBC) Act 1999* approval is subject to thirteen conditions. Condition number four required Jandakot Airport Holdings (JAH) to submit an Offset Plan to the Minister for approval. In 2010 the Australian Department of Sustainability, Environment, Water, Population and Communities (SEWPaC) gave JAH the approval required under the *EPBC Act 1999* to clear up to 167 ha of native vegetation to construct a fourth runway and associated taxiways, runway extensions, and clear land for the development of aviation and commercial precincts. This approval included the requirement to fund several offsets including the provision of $9.2 million to the Western Australian Department of Conservation and Environment (DEC, now Department of Biodiversity, Conservation and Attractions) to undertake restoration of banksia woodland. This funding allowed Parks and Wildlife to establish a team specialised in restoration ecology to undertake the Banksia Woodland Restoration (BWR) project. Management actions undertaken by the BWR project are summarised in separate reports and only aspects relating to site selection are considered below.

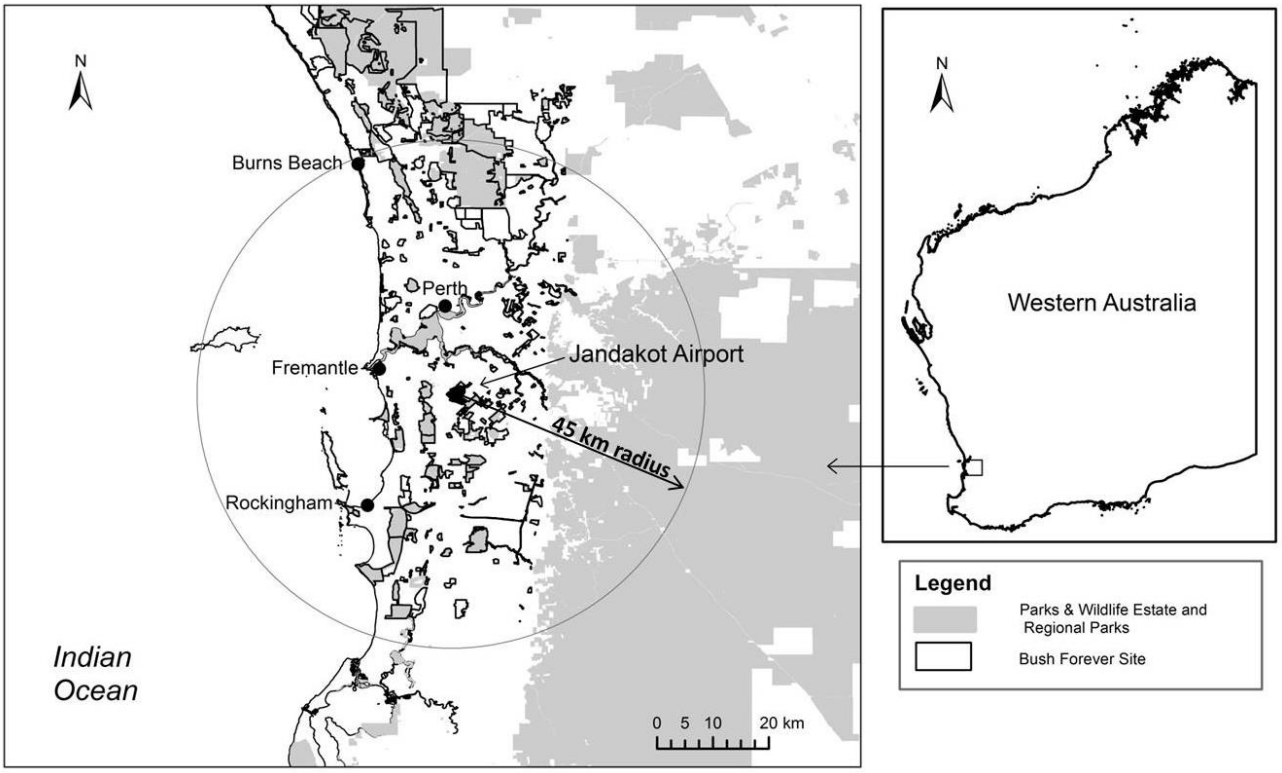

Figure 1. The location of Jandakot Airport in relation to Perth, the capital of Western Australia. The 45 km radius circle denotes the area specified for site selection by the ministerial conditions in approval notice EPBC 2009/4796.

In 2011, Parks and Wildlife Swan Region developed a site selection process as part of an adaptive management approach to guide decisions using a scientifically rigorous process. This occurred in the first year of the project due to the urgent timeframes driven by the schedule for land clearing and topsoil availability from Jandakot Airport. While clearing was approved in 2009, the implementation of the project was delayed by administrative issues in finalizing agreements between the federal government, JAH and Parks and Wildlife. Clearing of the best condition area of native vegetation was moved forward by one year to early 2012 by Jandakot Airport Holdings giving Parks and Wildlife extremely tight timelines for the topsoil transfer part of the project in April-May 2012.

We have observed that previous and existing projects using topsoil transfer to create banksia woodland on the Swan Coastal Plain of Perth have had highly variable success. Therefore to improve the likelihood of success the BWR project funding was used to fund two major components:

1. Restoration of banksia woodland on completely degraded sites using topsoil transfer and complimentary revegetation techniques such as direct seeding and planting of seedlings raised from local provenance seed.
2. Management actions to improve the condition of existing, high value banksia woodland sites within the conservation estate.

Consequently, two separate site ranking processes were required, one for topsoil-based restoration sites (Phase 1) and a second for sites with existing banksia woodland for a range of priority management actions addressing threatening processes (Phase 2).

In addition to the desktop site ranking process, site selection was also strongly driven by the presence and accessibility of areas lacking existing native vegetation that were suitable targets for restoration. Knowledge of the condition of native vegetation was another major factor required prior to determining weed control and other management actions. The purpose of this report is to document the desktop methods used to rank potential sites based primarily on conservation values and explain how these data were selected and utilized. Final site selection relied on site-specific knowledge provided by departmental staff, on ground site inspections and the practical operational requirements of the various activities that needed to be undertaken for topsoil transfer and management actions.

Methods

The site selection process primarily addressed the threats to matters of national significance identified in SEWPaC's approval process. These threats were loss of feeding habitat for the nationally threatened Carnaby's cockatoo (*Calyptorhynchus latirostris*) and loss of threatened grand spider orchid (*Caladenia huegelii*) plants. As a result, the objectives of the BWR project were to:

- Create new banksia woodland to increase the available area of feeding habitat for Carnaby's cockatoo.
- Protect and improve the condition of existing banksia woodland used as Carnaby's cockatoos feeding habitat, especially areas containing types of banksia woodland similar to those being cleared at Jandakot Airport or types close to breeding or roosting sites.
- Protect and improve the condition of banksia woodland, especially in those areas most similar to Jandakot Airport, that have very high conservation values and areas supporting the Declared Rare Flora *Caladenia huegelii* (grand spider orchid).
- Develop protocols and recommendations for future banksia woodland restoration projects.

Three phases were undertaken in the site selection process, first a desktop review and ranking of conservation values for sites with some existing protection, then second a limited desktop review of threats, and finally an iterative Delphi review (expert knowledge) process of threats and management issues for the most highly ranked sites, including on ground assessments as required. Site selection criteria are listed in Appendix 1 and explained further below.

The Commonwealth ministerial conditions under approval EPBC 2009/4796 stated that only sites within a 45 km radius of Jandakot Airport containing or once supporting banksia woodland should be considered, so distance from Jandakot Airport was used as the first selection criteria (Appendix 1).

For the restoration of banksia woodland by topsoil transfer, degraded areas within or adjacent to existing, protected, and high value banksia woodland areas were targeted to consolidate these sites. Sites with relatively intact vegetation were also selected for the conservation of existing banksia woodland through

rehabilitation activities. For the latter, site selection focused on existing protected, high value banksia woodland sites. Areas were chosen that would substantially benefit from activities such as weed management, fencing, or overstory recovery by planting banksias in areas severely affected by drought deaths.

Taking a best practice approach, site selection focused initially on sites containing the type of habitat being lost at Jandakot Airport. This meant selecting areas of banksia woodland that most closely matched the abiotic and biotic characteristics of the area being cleared to maximize the opportunity for successful restoration using topsoil. It was important to match the landform, soils, topography and type of banksia woodland as closely as possible to find completely degraded areas that once supported this type of banksia woodland. These sites also needed to be secure for conservation purposes or be in the process of being made secure so that Department of Biodiversity, Conservation and Attractions staff had full access.

A number of different types of banksia woodland occur on the Swan Coastal Plain IBRA Bioregion and several floristic community types occur around Jandakot Airport. The 45 km radius from Jandakot Airport covers primarily the Perth Metropolitan Region (PMR) extended a short way south into the Peel Region. The assessment of natural areas here is based on Bush Forever (Government of Western Australia 2000a&b) because this is the main conservation plan for the Swan Coastal Plain portion of the Perth Metropolitan Region.

Carnaby's cockatoos are often observed feeding in banksia woodland, so several criteria were used to rank sites based on their potential importance as feeding areas. The presence of Carnaby's cockatoos roosting or nesting sites in close proximity was also used as a major ranking criterion.

Caladenia huegelii (grand spider orchid), which is both federally and state listed as threatened flora, is also affected by the clearing at Jandakot Airport. Offset funds have been allocated to the Botanic Gardens and Parks Authority for research into propagation and transplantation techniques for this species. However, Parks and Wildlife Swan Region has an obligation to implement recovery plan actions for this species and ensure management works are undertaken to achieve *in situ* conservation as well as successful translocation projects. Consequently, the presence of *C. huegelii* or other threatened flora was also used as ranking criteria.

A database of selection attributes for all Bush Forever sites was created using information extracted from existing and purpose designed GIS datasets, plus additional data manually extracted from the standardized site descriptions of each Bush Forever site (Government of Western Australia 2000) (Appendix 1). The scoring system developed to rank the Bush Forever sites was tested for robustness through several iterative trials using different classification value systems (with enumeration formulae applied to some) and different weighting multipliers. The final system used consistently ranked the same sites of highest value despite changing classification values and/or weighting multipliers to adjust the importance of various factors in the ranking. Note: the attribute, ecological linkages, which would normally be considered in a site selection exercise, could not be included due to lack of available suitable GIS datasets.

For each criteria listed in Appendix 1 a multiplier was applied to scale its influence on the analysis based on our perceived importance of that criteria. These weighing factors are listed in Appendix 2. along with measurement units, classification scales and datasets used. The strongest multipliers were applied to sites within 45 km from Jandakot Airport and feeding habitat for Carnaby's cockatoos, as these were stated as key requirements in the ministerial conditions.

Based on the application of the criteria and scoring system described, all 285 Bush Forever sites were ranked to determine the most suitable sites for topsoil transfer. These sites most closely matched the soil, landform and vegetation types of Jandakot Airport. This was undertaken using FME Desktop 10 (Safe Software) and ESRI ArcMap 9.3 for GIS processing. A list of the top 30 Bush Forever sites ranked for restoration by topsoil transfer is provided in Appendix 3 and an example of the scoring and outcome of application of the criteria to the two sites finally chosen as topsoil transfer recipients is shown in Appendix 3.

Bush Forever sites contain a mixture of land tenures; therefore, the next step was to identify those sites containing substantial secure areas for conservation, where Parks and Wildlife had full access and control over management. For operational reasons the group responsible for management of each site/part site within Parks and Wildlife had to be assigned to allow consultation with the appropriate staff responsible for these sites. Essentially, within Parks and Wildlife Swan Region there are two distinct management groups to be consulted, the Swan Coastal District Office and the Regional Parks Office.

A separate GIS process was performed to calculate areas for “Tenure Category”. The "Tenure Category" was assigned after all the other prioritization work was undertaken. Three lists were generated based on tenure categories defined as shown in Table 1.

During the tendering process for the topsoil harvesting, transfer and spreading, the high costs of this part of the project became more apparent and a decision was made to limit site selection to sites within 20 km of Jandakot Airport (excluded sites shaded grey at bottom of Appendix 4). This sub-set of ‘close’ sites were then prioritized for site visits based on examination of aerial photographs and remnant vegetation mapping to find large secure areas of cleared land that were thought to have previously supported upland banksia woodland. The donor site, Jandakot Airport Precinct 5, covered approximately 40 ha but only about 18 ha of the vegetation was in ‘Very Good’ condition and suitable for topsoil harvesting. Therefore, recipient sites, totalling at least 18 ha were required.

The ranking process was then modified for Phase 2 to help select sites for the conservation of existing banksia woodland through various rehabilitation activities. For this process, site selection focused on protected, high value banksia woodland sites, with less emphasis on distance from Jandakot Airport. The detailed results for Phase 2 are reported in Jackson *et al.* (in prep).

Table 1. Explanation of tenure categories used for desktop ranking of sites for Phase 1: topsoil transfer from Jandakot Airport. All datasets are cited in Appendix 2.

Tenure Category	Meaning	Data source (Dataset)
Secure	Regional Park with whole or significant proportion of site in Parks and Wildlife estate	BF_Ranking_Secure_Tenure_RegPK_or_better
Reg Park	More than 30% of site in Regional Park, no large proportion of site with more secure tenure than Regional Park	BF_Ranking_Tenure_RegPk_30percent_or_more
LG or Unsecure	More than 50% of site managed by Local Government (LG) or not secure	BF_Ranking_Tenure_INsecure_50percent_or_greater

Note: a given Bush Forever site could occur on more than one list or it could occur on only one list that may not reflect who is actually managing the site. For example, all of Thomson’s Lake and a large area around it is protected as Parks and Wildlife Estate, with more than 50% of this site in Thomson’s Lake Nature Reserve. However, all of Bush Forever site no. 391 is also designated a regional park and is therefore managed by the Regional Parks Office within the Department of Biodiversity, Conservation and Attractions. A large portion of the site is secure as a nature reserve and not included in the list sent to Regional Parks for consultation.

Results and Discussion

The process described above allowed all Bush Forever sites to be ranked according to a comprehensive set of selection criteria that primarily focused on biodiversity conservation values. Ranking outcomes for restoration are summarised in Figure 2, with detailed results presented in Appendix 3 and 4. Two large sites consisting of open paddocks with only a few scattered native plants were finally selected for restoration using topsoil transfer after consultation with land managers and site inspections, one at each of Jandakot Regional Park and Forestdale Lake (Figure 3). These two topsoil recipient sites had been recently purchased by the Western Australian Planning Commission for inclusion into the conservation estate and were already under Parks and Wildlife management. In addition, a small amount of topsoil was also used to restore tracks in Ken Hurst Park. This local government reserve is managed by the City of Melville and is adjacent to Jandakot Airport.

It is evident in Figure 2 that the site selection process was biased towards larger areas of vegetation that were most similar to Jandakot Airport (banksia woodland on Bassendean Dune soils). Many of these areas are in Jandakot and Beeliar Regional Parks. However, several other large areas were identified in the Gnangara Groundwater Mound area, but were more than 45 km from the topsoil source area and hence did not conform to the final inclusion criteria. One large area known as “Lowlands” was also identified on the southern boundary of the study area, but was privately owned at the time of site selection.

The second phase of the desktop assessment process ranked sites with relatively intact vegetation for management actions. All sites containing banksia woodland, secure for conservation purposes and within a 45 km radius of Jandakot Airport were considered. The analysis was repeated with criteria 3 and 12 removed and new criteria 17 and 18 included (Appendix 5). Criterion 3, exact distance from Jandakot Airport, was no longer relevant and Criterion 12 was replaced more specifically by Criterion 17. These modifications identified all secure sites containing banksia woodland (Criterion 17) and picked up sites with types of banksia woodland different to those at Jandakot Airport (Criterion 18), particularly those with a range of Floristic Community Types and hence higher biodiversity value as well as providing a diversity of feeding habitat for Carnaby’s cockatoos. The original criterion targeting sites containing banksia woodland similar to Jandakot Airport (Criterion 11) was retained because one of the main objectives of the offset process was to improve the condition of areas similar to those being cleared.

The scoring system used was also modified to reflect the reasoning above. The importance of the site being within a 45 km radius of Jandakot Airport was reduced and the new criterion for the presence of banksia woodland was given the highest score in the system so that large, diverse sites outside the 45 km would not be missed. This was necessary as the southern part of the Perth Metropolitan Region, where Jandakot Airport is sited, is more heavily cleared and fragmented than the northern parts. The largest most diverse banksia woodland sites tend to occur in the north, beyond the 45 km radius. Many of these sites are of very high conservation value but could not be included due to the limitations of the “distance from Jandakot Airport” criteria.

The results of the Phase 2 ranking are shown in Figure 4. When outputs of the two rankings are compared results are similar (compare Figure 2 to Figure 4), but the importance of larger areas of remnant vegetation was increased in the Phase 2 ranking. For example, comparison of colour coding of sites in Figures 2 and 4 reveals that large sites containing banksia woodland in the Spearwood Dune system, such as Paganoni Bushland ion the southern perimeter of Perth, ranked much higher in Phase 2.

The importance of State listed rare and priority species and communities were increased in Phase 2. This desktop ranking was then reviewed by expert land managers within the Department of Biodiversity, Conservation and Attractions with site-specific knowledge, of vegetation condition and site history. This information is rarely captured in databases or by GIS datasets. The final ranking of sites for management actions such as weed control is detailed in a separate report (Jackson *et al.*, in prep.).

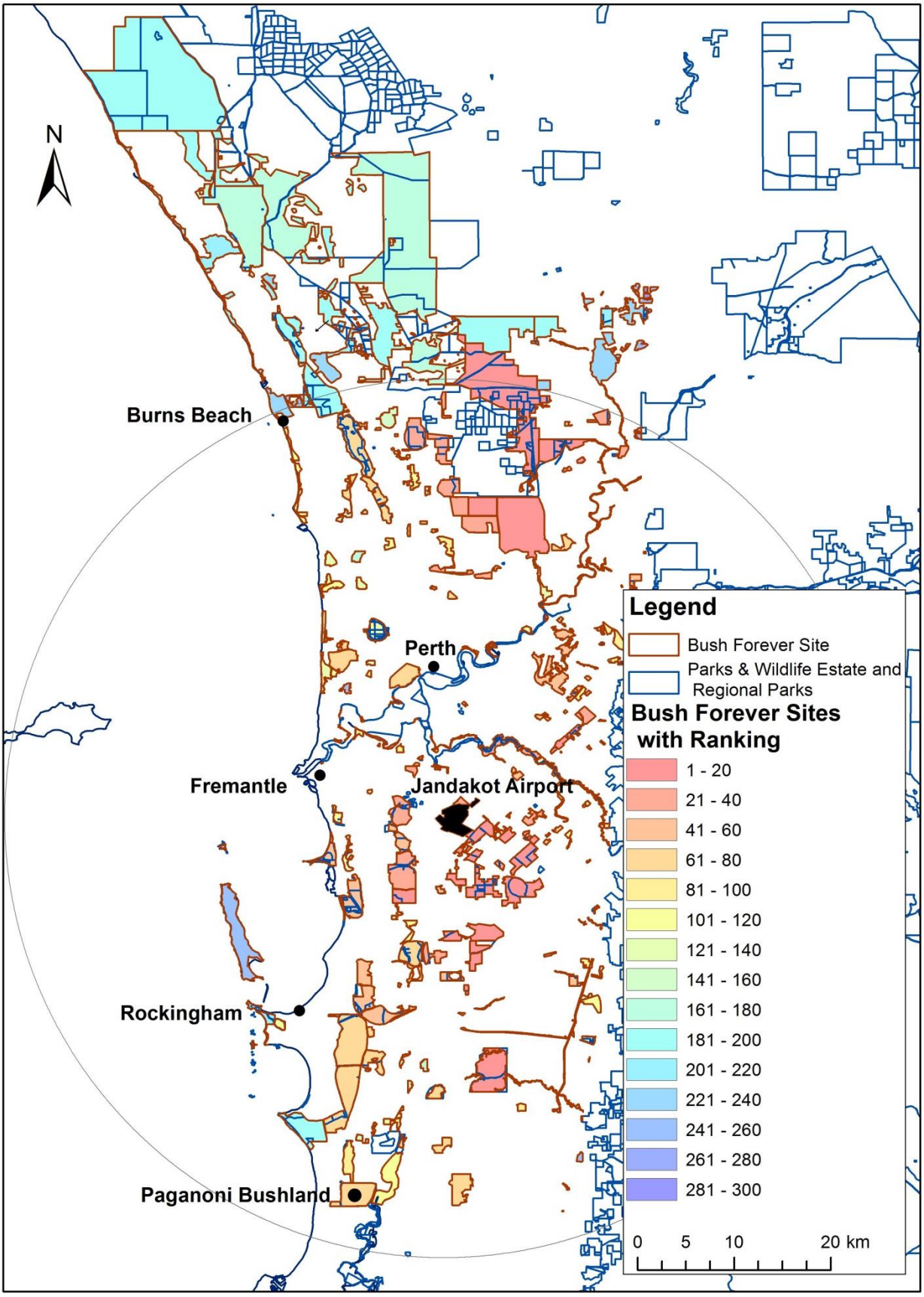

Figure 2. Color coded summary of results of site ranking process, based on conservation values and similarity to Jandakot Airport banksia woodland, for all Bush Forever sites that were used to help select areas for restoration using topsoil and seed from jandakot airport (the highest ranked areas are pale red followed by orange, yellow, green and blue).

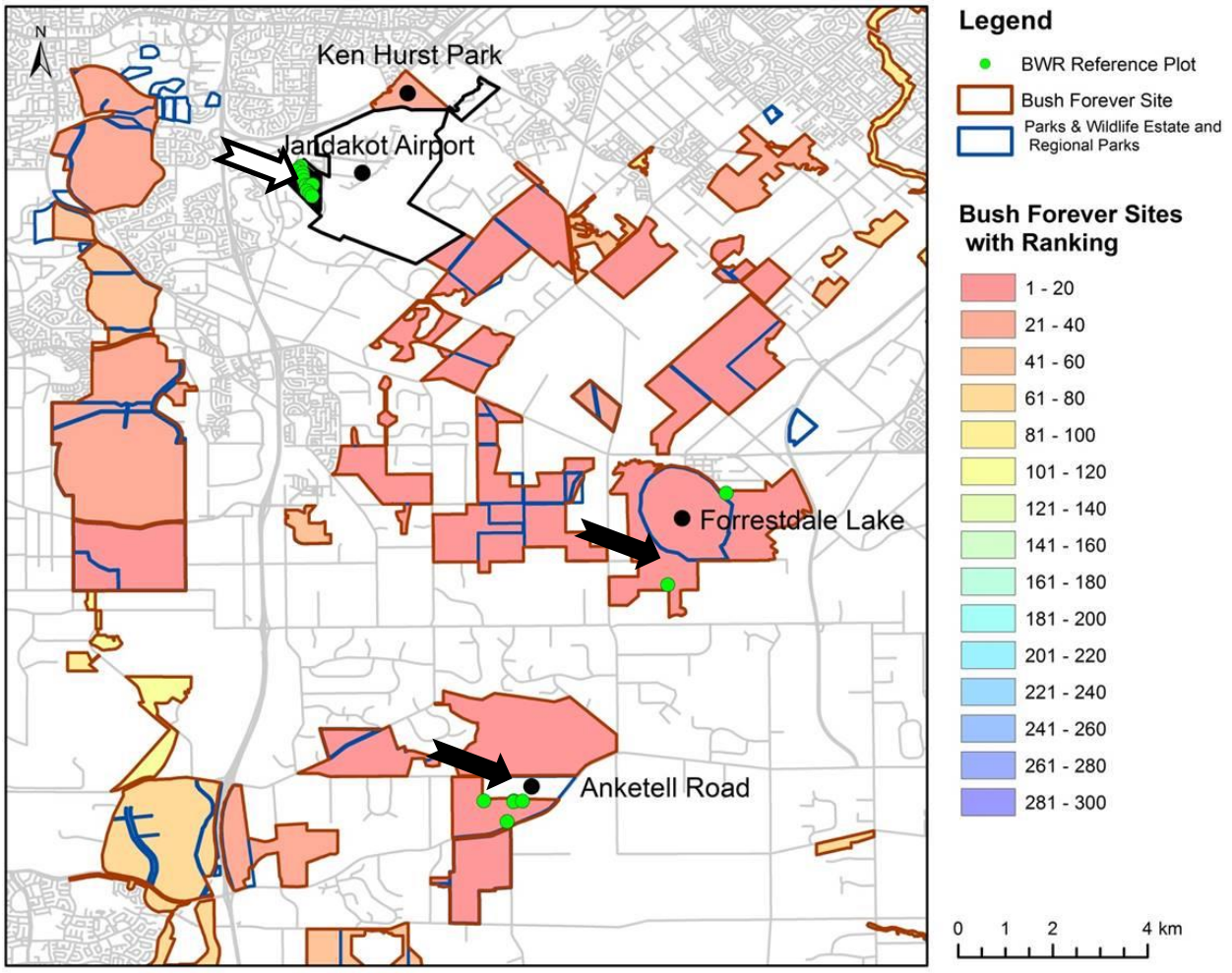

Figure 3. The location of reference sites for restoration (green dots) relative to the topsoil source area at Jandakot Airport (outlined arrow) and topsoil transfer restoration sites (filled arrows). Bush Forever sites and the boundaries of Jandakot and Beeliar Regional Parks are indicated by blue borders and other reserves in the Parks and Wildlife estate near Jandakot Airport are indicated by green borders. Site rankings for Bush Forever sites are indicated by colour-coding.

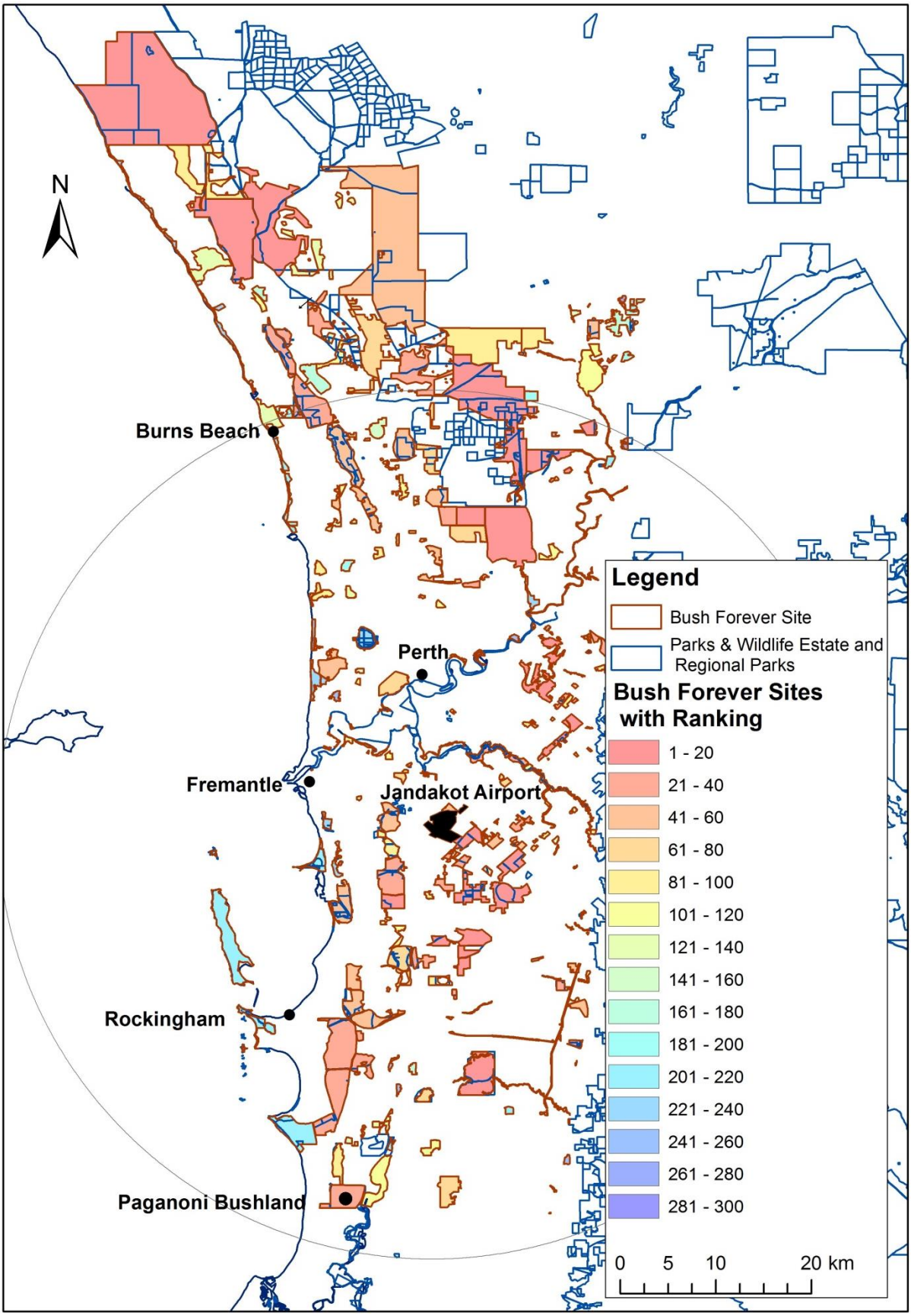

Figure 4. Color coded summary of results of site ranking process, based on conservation values and similarity to Jandakot Airport banksia woodland, for all Bush Forever sites that were used to help select areas for site management actions such as weed control (the highest ranked areas are pale red followed by orange, yellow, green and blue).

Conclusions

The approach described in this report proved to be a valuable tool for prioritizing a large number of sites in a reasonable amount of time without requiring expertise in data modelling. Highly ranked sites matched the expectations of experts with many years of experience in the region. The dataset developed could be modified to select sites for other restoration projects or for efficient allocation of funding for management actions. This could be achieved simply by removing or modifying criteria specific to the Banksia Woodland Restoration project's primary objectives, followed by addition of new criteria matching the new objectives. For example, distance to Jandakot Airport could be removed and the weighting of scores increased for factors such as threatened flora, fauna and ecological communities. The approach can be used to rank sites in Swan Region's Parks and Wildlife estate for conservation planning by expanding and adjusting the dataset appropriately.

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Appendix 1. Explanation of criteria used for desktop ranking of sites for Phase 1: topsoil transfer from Jandakot Airport. All datasets are cited in Appendix 2.

No.	Criteria	Justification
A	**Inclusion Criteria**	
1	Site within 45 km of Jandakot Airport	Department of the Environment, Water, Heritage and the Arts (2010) condition 4(b). Primarily Perth Metropolitan Region (Figure 1).
2	Bush Forever site	Banksia woodland of type being cleared at Jandakot Airport only occurs on Swan Coastal Plain (SCP). Bush Forever (Government of Western Australia 2000) is the current conservation plan for SCP portion of Perth Metropolitan Region.
3	Site contains remnant vegetation mapped as potential feeding habitat for Carnaby's cockatoos	One of the main objectives of the offset is to increase and improve the feeding habitat available for Carnaby's cockatoos (Department of the Environment, Water, Heritage and the Arts 2010)
B	**Primary Ranking Criteria – conservation values matters of national significance**	
4	Site with secure tenure for conservation (Parks and Wildlife estate) or secure tenure in progress (to the point where Parks and Wildlife has full access)	Secure tenure required to ensure investment in restoration works are not wasted and are available for the long-term conservation of banksia woodland.
5	Large area of remnant vegetation in site with secure tenure or secure tenure in progress	The larger the area of remnant vegetation the more likely it is to be resilient to threatening processes and have long term viability.
6	Site containing a confirmed breeding site of Carnaby's cockatoos or within the 12 km feeding buffer of a confirmed breeding site	Breeding sites are diminishing and breeding success relies on enough food resources being available within a 12 km radius of the nest site (Valentine and Stock 2008)
7	Site containing a possible breeding site of Carnaby's cockatoos or within the 12 km feeding buffer of a possible breeding site	As above

No.	Criteria	Justification
8	Site containing a confirmed night roost site of Carnaby's cockatoos or within the 6 km feeding buffer of a confirmed night roost site	Night roost sites are diminishing and bird health is believed to require adequate food resources being available within a 6 km radius of the roost site.
9	Site containing a possible night roost site of Carnaby's cockatoos or within the 6 km feeding buffer of a possible night roost site	As above
10	Site containing the Declared Rare Flora *Caladenia huegelii*	Species listed under the EPBC Act that occurs in the clearing area Precinct 5. Therefore, restoration activities at secure sites containing *C. huegelii* will contribute to the long-term *in situ* survival of this threatened species.
11	Site containing banksia woodland similar to Jandakot Airport	
11a	Site in Bassendean Dunes major landform element	Major Landform Element match to Jandakot Airport
11b	Site with upland Floristic Community Type/s (FCTs) the same as those at Jandakot Airport: 21c Low-lying *Banksia attenuata* woodlands or shrublands 22 *Banksia ilicifolia* woodlands 23a Central *Banksia attenuata — B. menziesii* woodlands	Banksia woodland floristic community type matches to Jandakot Airport. FCT's are consistent with Bush Forever Volume 2 (Government of Western Australia 2000).
11c	Site with upland vegetation complex the same as Jandakot Airport: Bassendean Complex — Central and South	Banksia woodland vegetation complex match to Jandakot Airport. Vegetation complex consistent with Bush Forever Volume 2 (Government of Western Australia 2000).
12	Proximity of site to Jandakot Airport	Transport costs of topsoil from Jandakot Airport prohibitive therefore need to select topsoil transfer sites as close to airport as possible

No.	Criteria	Justification
13	Total area of remnant vegetation in site	The larger the area of remnant vegetation the more likely it is to be resilient to threatening processes and have long term viability.
C	**Secondary Ranking Criteria – conservation values of WA state significance**	
14	Declared Rare Flora (DRF) or Priority flora: WA State listings	Very high conservation significance
15	Threatened (TEC) or Priority (PEC) Ecological Communities: WA State listings	Very high conservation significance
16	Threatened or priority fauna: WA State listings	Very high conservation significance

Appendix 2. Explanation of scoring system used for desktop ranking of sites for topsoil transfer from Jandakot Airport. *na = not applicable

No.	Criteria	Importance	Initial Measurement Units	Classification Values or Enumeration Formula	Weighting Multiplier	Notes	GIS Dataset used
Inclusion Criteria							
1	Site within 45 km of Jandakot Airport	high	distance (km)	If distance < 45 km assign value of 1	50	distance to closest point of site	
2	Bush Forever site	high	na*	na	0	Only Bush Forever sites selected, no score required.	Bush Forever 2009, Parks and Wildlife corporate
3	Site contains remnant vegetation mapped as potential feeding habitat for Carnaby's cockatoos	high	area (ha)	If area > 1 ha assign value of 1	50		CBC feeding habitat, Parks and Wildlife corporate, (Glossop *et al* 2010)
Primary Ranking Criteria – conservation values matters of national significance							
4	Site with secure tenure for conservation (Parks and Wildlife estate) or secure tenure in progress (to the point where Parks and Wildlife has full access)	high	category expertly ranked	Parks and Wildlife Estate = 5, Part Parks and Wildlife Estate (95% or less) = 4, WAPC land being transferred to Parks and Wildlife= 3, Regional Park = 2, MRS zoning as Parks & Recreation = 1 (Value 0, 1, 2, 3, 4, or 5)	1	Assign highest score where several categories are present or overlap occurs.	Parks and Wildlife Estate, Parks and Wildlife corporate. WAPC land yes, Parks and Wildlife Swan Region 2011. Regional Parks, Parks and Wildlife corporate.

No.	Criteria	Importance	Initial Measurement Units	Classification Values or Enumeration Formula	Weighting Multiplier	Notes	GIS Dataset used
5	Large area of remnant vegetation in site with secure tenure or secure tenure in progress	high	proportion of site	IF area secure is > 1 ha assign proportion of site in secure tenure to value (value 0 - 1)	1	Secure = either whole or part of site Parks and Wildlife estate, WAPC land being transferred to Parks and Wildlife or Regional Park	Remnant Vegetation (2009) Parks and Wildlife corporate
6	Site containing a confirmed breeding site of Carnaby's cockatoos or within the 12 km feeding buffer of a confirmed breeding site	high	area (ha)	IF area of intersection > 1 ha assign value of 1 (Value 0 or 1)	1	Area is intersection between BF site and confirmed breeding site buffered to 12km	CBC confirmed breeding sites, Parks and Wildlife corporate (2010)
7	Site containing a possible breeding site of Carnaby's cockatoos or within the 12 km feeding buffer of a possible breeding site (there is reported evidence for these sites, but they may not have been confirmed or may no longer be in use)	high	area (ha)	IF area of intersection > 1 ha assign value of 1 (Value 0 or 1)	0.5	Area is intersection between BF site and possible breeding site buffered to 12km. Value reduced by 50% as only possible site.	CBC possible breeding sites, Parks and Wildlife corporate (2010)
8	Site containing a confirmed night roost site of Carnaby's cockatoos or within the 6 km feeding buffer of a confirmed night roost site	high	area (ha)	IF area of intersection > 1 ha assign value of 1 (Value 0 or 1)	1	Area is intersection between BF site and confirmed night roost site buffered to 6km	CBC confirmed night roosts, Parks and Wildlife corporate (2010)
9	Site containing a possible night roost site of Carnaby's cockatoos or within the 6 km feeding buffer of a possible night roost site (there is	medium	area (ha)	IF area of intersection > 1 ha assign value of 1 (Value 0 or 1)	0.25	Area is intersection between BF site and possible night roost site buffered to 6km.	CBC possible night roosts, Parks and Wildlife corporate (2010)

No.	Criteria	Importance	Initial Measurement Units	Classification Values or Enumeration Formula	Weighting Multiplier	Notes	GIS Dataset used
	reported evidence for these sites, but they may not have been confirmed or may no longer be in use)					Value reduced by 75% as only possible site and greater uncertainty in possible night roost sites compared to possible breeding sites.	
10	Site containing the Declared Rare Flora *Caladenia huegelii*	high	population count	Count used but if > 5 it was reduced to 5 (Values 0-5)	1		Declared Flora, DEC, extracted June (2011a)
11	Site containing banksia woodland similar to Jandakot Airport	high		Total of a), b) & c) Values 0.1-3.0			
11A	Site in Bassendean Dunes major landform element	high	category expertly ranked	Bassendean Dunes = 10, Combinations of Bassendean Dunes & Spearwood Dunes & Pinjarra Plain = 9, Spearwood Dunes = 8, Pinjarra Plain = 7, Foothills = 6, Gingin Scarp = 5, Dandaragan Plateau = 4, Quindalup Dunes = 3, Wetlands = 2, Marine =1 (Values 1-10)	0.1	Assign value of Major Landform Element of largest area in BF site if several present. Reduce value to range of 0.1-1.0 to give same weighting as 11B) & 11C)	Developed from Heddle *et al* (1980) vegetation complexes, Parks and Wildlife corporate . Based on Table 5, page 25 (Government of Western Australia 2000).

No.	Criteria	Importance	Initial Measurement Units	Classification Values or Enumeration Formula	Weighting Multiplier	Notes	GIS Dataset used
11B	Site with upland Floristic Community Type/s (FCTs) the same as those at Jandakot Airport FCTs 21c Low-lying *Banksia attenuata* woodlands or shrublands 22 *Banksia ilicifolia* woodlands 23a Central *Banksia attenuata — B. menziesii* woodlands	high	category expertly ranked	Values 5 - 3 = no. of matching upland FCTs, 2 = FCTs unknown but Bassendean Dunes with upland plant communities present, 1 = FCTs unknown but Bassendean Dunes with wetland plant communities only present OR FCTs unknown & not Bassendean Dunes, 0 = no match (Values 0, 1, 2, 3, 4, 5)	1	Number of matching upland FCT's	na
11C	Site with upland vegetation complex the same as Jandakot Airport Bassendean Complex — Central and South	high	category expertly assigned	0 = no match; 1 = match (Value 0 or 1)	1		
12	Proximity of site to Jandakot Airport	medium	distance (km)	5km/distance, max. = 1, (Value 0 - 1)	1	Distance from centre of Jandakot Airport to closest point of BF site	

No.	Criteria	Importance	Initial Measurement Units	Classification Values or Enumeration Formula	Weighting Multiplier	Notes	GIS Dataset used
13	Total area of remnant vegetation in site	high	area (ha)	< 1 ha assigned 0; Remainder had log base 10 applied. Log(RemVeg_area) (log base 10 will give values of 1,2,3 for 10,100,1000ha)	1		Remnant Vegetation (2009) Parks and Wildlife corporate
Secondary Ranking Criteria – conservation values of WA state significance							
14	Declared Rare Flora (DRF) or Priority flora: WA State listings	medium	category expertly ranked	DRF (Critical) = 5, DRF (Endangered) = 4, DRF (Vulnerable) = 3, Priority = 1 (Values 5, 4, 3, 1)	0.25	Highest value assigned when more than one possible. Values reduced by a quarter as WA state listed species of less importance in this federal government offset project	Declared Flora, DEC, extracted (2011a)
15	Threatened (TEC) or Priority (PEC) Ecological Communities: WA State listings	medium	category expertly ranked	TEC (Critical) = 5, TEC (Endangered) = 4, TEC (Vulnerable) = 3, PEC = 1 (Values 5, 4, 3, 1)	0.25	Highest value assigned when more than one possible. Values reduced by a quarter as WA state listed species of less importance in this federal government offset project	TEC PEC sites, Parks and Wildlife(2011b)
16	Threatened or priority fauna: WA State listings	medium	category expertly ranked	Rare (Critical) = 5, Rare (Endangered) = 4, Rare (Vulnerable) = 3, Other Specially Protected Fauna (OSP) = 2, Priority = 1 (Values 1 - 5)	0.25	Highest value assigned when more than one possible. Values reduced by a quarter as WA state listed species of less importance in this federal government offset project	Threatened and Priority Fauna database DEC, (2011b)

Note: references primarily refer to Geographic datasets managed by Parks and Wildlife

Appendix 3. The top 30 Bush Forever sites from initial desktop ranking of sites for topsoil transfer. Land tenure categories were assigned after ranking of conservation values. Table rows highlighted in yellow indicate the two sites selected for topsoil transfer, and rows that are grey (at the end of the table) were subsequently excluded once the prohibitive costs of topsoil transfer became known, even if highly ranked, due to a distance of more than 20 km from the topsoil source.

Rank	BF Site No.	BF Site Name	Distance from Jandakot Airport (km)	Area of Remnant Vegetation (ha)	% BF Site vegetated	Tenure Category 1	Tenure Category 2	Feasibility/suitability after examining air photos, remnant vegetation mapping and conducting site visits
1	347	Wandi Nature Reserve and Anketell Road Bushland, Wandi/Oakford	12	421	54	Secure	*RegPark	50 ha Regional Park managed area available with good access for machinery.
3	388	Jandakot Airport, Jandakot	0	349	44	Unsecure		Land managed by the Commonwealth, donor site for topsoil
6	344	Dennis De Young Reserve and Gibbs Road Swamp Bushland, Banjup/Forrestdale	7	307	80	Secure		No large cleared areas of upland
7	263	Banjup Bushland, Banjup	6	137	75	Secure	RegPark	No large cleared areas of upland
8	348	Modong Nature Reserve and Adjacent Bushland, Oakford	14	290	94	Secure	RegPark	No large cleared areas of upland
9	392	Harry Waring Marsupial Reserve, Wattleup	9	271	98	Secure		Marsupial reserve and research site managed jointly by the University of Western Australia
11	389	Acourt Road Bushland,	2	285	93	Secure	RegPark	No large cleared areas of upland

Rank	BF Site No.	BF Site Name	Distance from Jandakot Airport (km)	Area of Remnant Vegetation (ha)	% BF Site vegetated	Tenure Category 1	Tenure Category 2	Feasibility/suitability after examining air photos, remnant vegetation mapping and conducting site visits
		Banjup						
12	345	Forrestdale Lake and Adjacent Bushland, Forrestdale	9	334	84	Secure		5 ha of Parks and Wildlife Estate available with good access for machinery
13	353	Banksia Road Nature Reserve, Peel Estate	17	32	75	Secure		No large cleared areas of upland
14	342	Anstey/Keane Dampland and Adjacent Bushland, Forrestdale	7	311	88	Secure	RegPark	No large cleared areas of upland
15	387	Greater Brixton Street Wetlands, Kenwick	13	130	45	Secure		Main area of banksia woodland in Yule Brook Reserve managed by UWA
17	413	Balannup Lake and Adjacent Bushland, Southern River/Forrestdale	7	75	88	Secure		Mainly wetland vegetation types
19	390	Fraser Road Bushland, Banjup	4	124	65	Secure	RegPark	No large cleared areas of upland, major dieback infestation
20	253	Harrisdale Swamp and Adjacent Bushland, Forrestdale	5	97	97	Secure	RegPark	No large cleared areas of upland
21	224	Canning River Regional Park and Adjacent Bushland, Riverton to	8	170	53	Secure	RegPark	Mainly riverine vegetation types

Rank	BF Site No.	BF Site Name	Distance from Jandakot Airport (km)	Area of Remnant Vegetation (ha)	% BF Site vegetated	Tenure Category 1	Tenure Category 2	Feasibility/suitability after examining air photos, remnant vegetation mapping and conducting site visits
		Langford						
22	270	Sandy Lake and Adjacent Bushland, Anketell	14	178	96	Secure	RegPark	No large cleared areas of upland
23	262	Piarra Nature Reserve, Forrestdale	6	40	72	Secure		No large cleared areas of upland
25	125	Holmes Street Bushland, Southern River/Huntingdale	7	119	93	Secure		No large cleared areas of upland
27	320	Hartfield Park Bushland, Forrestfield	16	73	96	LG		Not Parks and Wildlife tenure
30	245	Ken Hurst Park, Leeming	2	47	85	LG		Not Parks and Wildlife tenure, small amount of topsoil applied for track restoration.
2	399	Melaleuca Park and Adjacent Bushland, Bullsbrook/Lexia	44	4056	95	Secure		> 20km from airport
4	300	Maralla Road Bushland, Ellenbrook/Upper Swan	39	642	99	Secure		> 20km from airport
5	304	Whiteman Park, Whiteman/West Swan	31	1542	55	LG	Park	> 20km from airport

Rank	BF Site No.	BF Site Name	Distance from Jandakot Airport (km)	Area of Remnant Vegetation (ha)	% BF Site vegetated	Tenure Category 1	Tenure Category 2	Feasibility/suitability after examining air photos, remnant vegetation mapping and conducting site visits
10	368	Lowlands Bushland - Eastern Block, Peel Estate	26	1030	97	LG		> 20km from airport
16	23	Cardinal Drive Bushland, Ellenbrook	39	26	95	Secure		> 20km from airport
18	192	Wetherell Road Bushland, Lexia/Ellenbrook	35	32	74	Secure		> 20km from airport
24	400	Twin Swamps Nature Reserve and Adjacent Bushland, Bullsbrook	43	171	95	Secure		> 20km from airport
26	307	Lightning Swamp and Adjacent Bushland, Noranda	25	72	96	LG		> 20km from airport
28	141	Numbat Road Bushland, Mariginiup	43	62	70	Secure		> 20km from airport
29	193	Gnangara Lake and Adjacent Bushland, Gnangara/Lexia	34	165	55	Secure	**LG or Unsecure	> 20km from airport

*RegPark = Regional Park, **LG = Local Government,

Appendix 4. Examples of scoring and application of the ranking criteria to the two sites eventually chosen as topsoil transfer recipients. Criteria 4 secure tenure scores are not whole numbers due to mixed tenure within each site. The values were calculated using the sum of values calculated from the proportion of the site of each tenure status.

Criteria			Scoring			Site	
Category	**No.**	**Brief Description**	**Range**	**Multiplier**	**Maximum Score**	**Anketell Road**	**Forrestdale Lake**
Inclusion	1	CBC feeding habitat	0 or 1	50	50	50.00	50.00
	2	Bush Forever site	-	-	-	-	-
	3	Within 45km Jandakot Airport	0 or 1	50	50	50.00	50.00
Primary Ranking	4	Secure tenure	0 ,1, 2, 3, 4, 5	1	5	2.14	2.94
	5	Proportion of site secure	0 - 1	1	1	0.74	0.47
	6	CBC breeding site	0 or 1	1	1	0.00	0.00
	7	CBC potential breeding site	0 or 1	0.5	0.5	0.50	0.50
	8	CBC roosting site	0 or 1	1	1	1.00	1.00
	9	CBC potential roosting site	0 or 1	0.25	0.25	0.00	0.25
	10	*Caladenia huegelli* present	0 - 5	1	5	5.00	0.00
	11a	Major Landform Element	0 - 10	0.1	1	1.00	0.90
	11b	Upland FCT match to JA	0 ,1, 2, 3, 4, 5	1	5	4.00	3.00
	11c	Veg Complex match to JA	0 or 1	1	1	1.00	1.00
	12	Proximity to JA	0 - 1	1	1	0.42	0.55
	13	Total area of remnant vegetation	0 - 3	1	3	2.62	2.52
Secondary Ranking	14	State Flora DRF or priority listing	1, 3, 4, 5	0.25	1.25	0.75	0.75
	15	State TEC or PEC listing	1, 2, 3, 4, 5	0.25	1.25	0.00	0.75
	16	State Fauna DRF or priority listing	1, 2, 3, 4, 5	0.25	1.25	0.75	0.75
Total					**128.5**	**119.93**	**115.38**
Rank						**1**	**12**

Appendix 5. Explanation of criteria changes applied in Phase 2 used for desktop ranking of sites for management actions to conserve existing banksia woodland.

No.	A. Criteria Removed	Justification
3	Site contains remnant vegetation mapped as potential feeding habitat for Carnaby's cockatoos (Glossup 2010)	Only banksia woodland being targeted and all banksia woodland is potential feeding habitat for Carnaby's cockatoos.
12	Proximity of site to Jandakot Airport	Transport costs from Jandakot Airport no longer relevant.
No.	**B. Criteria Added**	**Justification**
17	Site contains banksia woodland	Department of Environment, Water, Heritage and the Arts (2010) condition 4(b) rehabilitation and conservation of banksia woodland
18	Site contains upland banksia woodland FCTs different or additional to those occurring at Jandakot Airport	Extends scope of project to all banksia woodland types on the SCP with emphasis on the more diverse (and hence usually larger) sites containing a number of different banksia woodland FCTs.