5 IMPACTS TO FLORA AND VEGETATION

5.1 KEY FINDINGS

- Approximately 9,800 ha of native vegetation is intersected by the development footprints of areas designated for future development to support a population of 3.5 million. This represents 2.5 per cent of all remnant vegetation in the Advice Area.

- This is a substantially smaller area than originally conceived, as a result of avoidance achieved during the footprint planning phase for urban, industrial and rural residential expansion areas; master planning of BRM; and application of co-location principals for infrastructure. An overall reduction in native vegetation intersected by development footprints of more than 16,400 ha (62 per cent) has been achieved to date through avoidance measures.

- Following this substantial avoidance, environmental values that have the potential to be impacted within the development footprints include: Regionally Significant Natural Areas (3,304 ha); Conservation category wetlands (461 occurrences), vegetation complexes <30 per cent remaining (5,752 ha), Threatened ecological communities (92 ha), and Threatened flora species (10 records/populations).

- Estimates have been made of future likely avoidance through statutory planning in urban, industrial and rural residential expansion areas, with the expected outcome to be avoidance of a further 1,261 ha of Regionally Significant Natural Areas, 125 Conservation category wetlands, 2,094 ha of vegetation complexes <30 per cent remaining, 24 ha of Threatened ecological communities and one Threatened flora species population. No estimate has been made for areas of urban consolidation activity in the Central sub-region, where further avoidance and minimisation is expected to be achieved. Further avoidance and minimisation should also be achieved through refinement of the infrastructure development footprint.

- A number of commitments are included in Action Plan G of the Strategic Conservation Plan to ensure the EPA objective for flora and vegetation is achieved, including offsets to transfer at least 170,000 ha into the formal conservation reserve system and conduct revegetation and replanting programs in conservation reserves, RSNAs, open space and other retained areas.

5.2 EPA OBJECTIVE

The following EPA objective for flora and vegetation is applicable to this assessment:

“To maintain representation, diversity, viability and ecological function at the species, population and community level.”

5.3 ENVIRONMENTAL POLICY AND GUIDANCE

The following policy and guidelines are relevant to this assessment with regard to flora and vegetation:

- The Australian Biodiversity Strategy 2010-2030 (NRMMC 2010);
5.4 EXISTING ENVIRONMENT

5.4.1 Overview

The bushland and wetland areas in Perth and its surrounds greatly contribute to the aesthetic and recreational value of the city (EPA 2013b). The Advice Area lies in the South West Botanical Province of WA, internationally recognised as a biodiversity hotspot. This Province supports an estimated 8,000 native vascular plant taxa, representing two thirds of the estimated plant taxa in WA (Hopper et al. 1996; Beard et al. 2000 as cited in EPA 2006b). Over 80 per cent of the plant taxa in the South West Botanical Province are endemic to the province (Beard et al. 2000 as cited in EPA 2006b). The Advice Area falls within the Swan Coastal Plain and Jarrah Forest bioregions as defined under the Interim Biogeographic Regionalisation of Australia (IBRA) (Thackway and Cresswell 1995) and

3 In 1995 Australia was divided into a series of natural regions through the IBRA (Thackway and Cresswell 1995). These natural regions have been defined based on the occurrences of flora and
supports over 2,000 native vascular taxa, many of which are naturally rare because of restricted distributions or specific habitat requirements (EPA 2015a).

The Advice Area has been subject to a high degree of disturbance as a result of land development, establishment of services and infrastructure, and agricultural practices. Cumulative impacts to the biodiversity of the Swan Coastal Plain over more than 180 years of development have been significant (EPA 2013b). Vegetation clearing is one of the main causes of biodiversity loss, particularly for urban development in coastal and peri-urban areas (EPA 2013b). The Swan Coastal Plain has experienced significant loss of native vegetation; 75 per cent all native vegetation in the bioregion has been cleared (EPA 2013b). Remnant vegetation in the bioregion is therefore of high conservation value and must be protected for the future.

Critical issues for flora and vegetation in the Advice Area are discussed in this chapter under the following categories:

- Regionally Significant Natural Areas (RSNAs);
- wetlands;
- poorly reserved vegetation complexes;
- Threatened and Priority Ecological Communities; and
- Threatened and Priority flora species.

Key values for each of these categories are described in detail within the respective impact analysis sections of the chapter.

### 5.4.2 Key threats

Flora and vegetation values in the Advice Area have the potential to be affected through the following threats:

- Disturbance from clearing.
- Disturbance from uncontrolled access and/or increased usage of land, such as recreational use (e.g. four-wheel driving, camping, fishing and crabbing, horse-riding, dog walking, bird watching and boating).

fauna and their interactions with geology, landforms and climate. The IBRA has since undergone several revisions to boundaries and regions and the latest version (IBRA7) recognises 27 bioregions and 55 sub-regions within WA (DoE 2014a).
• Changes to surface water and groundwater resources on which flora and vegetation is dependent. This includes alterations to water levels and quality beyond the tolerance of the dependent values arising from:
  o lowering of the watertable (including use requiring licensing, such as groundwater abstraction for non-potable and potable supply, and use exempt from licensing, such as garden bores);
  o decline in water quality from contamination/nutrient inflow;
  o activation of acid sulphate soils; and
  o alteration of drainage.
• Introduction of weeds.
• Alteration of fire regimes, which is likely to be exacerbated by future predicted increased temperature and decreased rainfall.
• Introduction of soil pathogens and plant disease.
• Climate change; in particular, the predicted future decline in rainfall and resulting fall in groundwater levels, is of particular concern for wetlands and groundwater dependent ecosystems. Impacts to surface and groundwater resources from development are likely to be exacerbated by future climate change.

5.5 CURRENT MANAGEMENT ARRANGEMENTS

5.5.1 Conservation reserve system and regional parks

Formally-recognised State and Regional Conservation Areas (IUCN I-IV) of high conservation significance include Nature Reserves, National Parks, Conservation Parks, Regional Parks and areas acquired and managed for the aforementioned purposes pending formal reservation. A number of conservation reserves occur within the Advice Area (Figure 5-1). These areas are fundamental to the current and future management of flora and vegetation in the Advice Area as they provide the highest level of protection to areas of remnant vegetation.

5.5.2 Regionally Significant Natural Areas

Within the Advice Area there are three key classifications to identify regionally significant areas of vegetation for protection pertaining to conservation recommendations that are endorsed by government:
• System 6;
• Bush Forever; and
• Peel Regionally Significant Natural Areas (Peel RSNAs).

Within the Advice Area, RSNAs are currently represented by System 6 areas in the eastern portion, Bush Forever in the western portion and Peel RSNAs in the southern portion (Figure 5-2). Within the Advice Area there are:
• 43 System 6 areas ranging in size from <1 ha to approximately 8,000 ha and covering a total area of approximately 55,200 ha;
282 Bush Forever sites ranging in size from <1 ha to approximately 8,000 ha and covering a total area of approximately 63,700 ha; and

146 Peel RSNAs, with a total of 811 occurrences ranging in size from <1 ha to approximately 1,700 ha and covering a total area of approximately 24,800 ha.

System 6

In 1972 EPA set up the Conservation Through Reserves Committee to study the provision of a set of reserves representing the major communities of natural wildlife and flora in WA. The State was divided into 12 regions or systems; the Advice Area is represented by System 6 (The Darling System) as defined by the then state Department of Conservation and Environment. Reserve conservation recommendations for the System 6 region were addressed in a report known as the EPA Red Book (EPA 1983). System 6 covers the most densely populated part of WA which includes the Perth Metropolitan Area, extending from Moore River in the north to Blackwood River in the south and includes the Swan Coastal Plain and Darling Range landforms.

The EPA began an update of System 6 in 1994 to deal with the large number of development proposals in the System 6 area brought to the EPA for assessment of their environmental impacts. The update focused on the southern Swan Coastal Plain, with the objective of reviewing the conservation recommendations for this region to take account of the more recent and much improved information available on flora and fauna (WAPC 2011). In 1996 this program was split, with priority given to the Perth Metropolitan Region of the Swan Coastal Plain through the Perth’s Bushplan project, which was completed with the release of Bush Forever in 2000 (WAPC 2011).

Bush Forever

Bush Forever is a strategic plan to ensure management issues relating to the conservation of bushland are appropriately addressed and incorporated within broader land use planning in the Perth metropolitan region (Government of Western Australia 2000). The aim of Bush Forever is to secure long-term protection of remnant bushland and conservation of biodiversity and associated environmental values.

Bush Forever initially identified 51,200 ha of regionally significant bushland for protection on the Swan Coastal Plain portion of the Perth Metropolitan Region (Government of Western Australia 2000). Of this, 33,400 ha was already under some form of protection; 13,200 ha was unprotected and in some form of government ownership; and 4,600 ha was unprotected and privately owned (Government of Western Australia 2000). The goal of Bush Forever is to preserve the identified 51,200 ha of regionally significant vegetation, representing, where achievable, a target of at least 10 per cent of each of the original 26 vegetation complexes of the Swan Coastal Plain portion of the Perth Metropolitan Region (Government of Western Australia 2000).

Regionally significant bushland was selected to be representative of the range of ecological communities (based on mapped vegetation complexes) in the Swan Coastal Plain portion of the Perth Metropolitan Region according to the following criteria:

- representation of the range of ecological communities and the places in which these communities merge;
- high diversity of flora and/or fauna species, or communities in close association;
- presence of rare or threatened communities or species, or species of restricted distribution;
• maintenance of ecological processes or natural systems at a regional or national scale;
• presence of evolutionary processes either as fossilised material or as relict species, presence of unusual or important geomorphological or geological sites, and/or areas of recognised scientific and educational interest as reference sites or examples of important environmental processes at work; and
• presence of Conservation category wetlands (CCWs) (including fringing vegetation and association upland vegetation) and/or coastal vegetation within the accepted coastal management zones.

The area covered by Bush Forever sites now amounts to 63,714 ha, of which 86 per cent is owned by State Government agencies, primarily WAPC, Parks and Wildlife and the Department of Lands (EPA 2015a). State agency ownership does not necessarily equate to protection, as the agency owner may have primary responsibilities other than biodiversity conservation. Of the 86 per cent in State agency ownership, approximately one quarter is in Nature Reserves, National Parks, Conservation Parks or other reserves with Conservation included in the purpose of the reserve (EPA 2015a). Most of the remainder is currently reserved for Parks and Recreation, which has multiple purposes and is not solely for conservation. Areas reserved for Parks and Recreation not dedicated to conservation provide the best opportunity to increase the level of conservation protection (EPA 2015a). A review of Bush Forever sites has been undertaken by DoP and the outcomes/recommendations of the review are to be implemented through continual acquisition of sites. It is recognised that many sites do not have conservation management orders and are at risk.

**Peel RSNAs**

An update of the remainder of the Swan Coastal Plain in the System 6 and System 1 areas was undertaken through the Swan Bioplan Project. This project was undertaken by the OEPA and the then DEC (now Parks and Wildlife) to identify landscape, habitat, vegetation and flora values across a study region which included the Swan Coastal Plain IBRA Bioregion south of the Perth Metropolitan Region and extended east to include the Darling and Whicher Scarps. Information from the project has been used to delineate RSNAs representative of landscapes, habitats, vegetation and flora that existed prior to extensive clearing on the southern Swan Coastal Plain (EPA 2010a).

The Swan Bioplan – Peel Regionally Significant Natural Areas (EPA 2010a) summarises this information for the Peel portion of the Swan Bioplan Project study region and identifies RSNAs in the Peel Sector of the Swan Coastal Plain that should be considered during strategic planning. Identification and selection of the Peel RSNAs was based on 2009 aerial photography and their natural values at the time, independent of current zoning or existing approvals that had yet to be implemented (e.g. Ministerial approvals, clearing permits or development approvals). The selection of the Peel RSNAs relied principally on information on landforms, soils, vegetation, flora and habitats. Specific consideration was given to include typical and unusual areas representing the major landforms, the consolidation of public lands containing highly significant natural areas, ecological linkages, and the conservation of tuart communities (EPA 2015a).

Nearly half of the Peel RSNAs are located in Nature Reserves, National Parks, Conservation Parks or other reserves with Conservation included in the purpose of vesting (EPA 2015a). The remainder are located in either State Government or private ownership. A strategy is therefore required for the long term protection of Peel RSNAs.
Figure 5-1: Major terrestrial conservation reserves of the Advice Area

Legend
- Advice Area
- Collaborative Australian Protected Area Database
- National Park
- Conservation Park
- Nature Reserve
- Reserve
- Bush Forever site

Datum/Projection: GDA 1994 MGA Zone 50
Data Sources: DPaW
Prepared by: SM Date: 17/11/2015
Figure 5-2: RSNAs within the Advice Area

Legend
- Advice Area
- RSNAs
  - Bush Forever
  - Peel RSNAs
  - System 6

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: EPA (June 2015)
Prepared by: SM Date: 17/11/2015
5.5.3 Identification and retention of important values through planning processes

A number of pieces of legislation enable the Western Australian planning system to comprise a framework of planning policy, statutory documents and processes to guide decision making and ensure appropriate development outcomes. The framework consists of:

- **Strategic planning** – the highest order planning documents developed and implemented by the WAPC or local government to provide guidance on planning, land use and development matters. Strategic planning documents provide the strategic basis for the development of statutory controls and provisions, but do not have any statutory powers themselves;

- **Statutory planning** – developed by the WAPC and local government to guide and control land use, subdivision and development in WA. Statutory planning documents have legal status and are enforceable; and

- **Spatial planning** – a framework for the coordinated provision of services, infrastructure, land use and development, and a guide to the intended pattern of future development of an area. Spatial plans are applicable at either the strategic or statutory level, and guide State and local government decision makers in assessment of rezoning, subdivision and development applications.

The above framework is implemented through the subdivision and development process, which consists of subdivision, development, review of decisions and enforcement. A number of mechanisms embedded within this framework provide consideration and protection of environmental values, particularly during local planning stages. These include the application or establishment of reserves, covenants on titles, scheme provisions, conditions on planning applications, and the designation of areas to be protected or rehabilitated on approved plans. Local planning policies can provide useful guidance on aspects of native vegetation protection and revegetation; for example, on-site biodiversity management, rehabilitation and landscaping using indigenous species, and measures to minimise the impacts of development in the vicinity of significant natural areas (EPA 2008c).

The Western Australian planning framework has and is able to provide for the protection of high environmental values through this system of planning processes; however, there is no single concise rule set that can be applied in each and every case to achieve environmental objectives. A nuanced approach is often required and the desired outcomes may be negotiated on a case by case basis. An important consideration when setting aside land for conservation is to consider who will be responsible for land management. Where the purpose is to fulfil a conservation objective, land management is generally the responsibility of Parks and Wildlife or local government, but may include others such as the WAPC and the Botanic Gardens and Parks Authority. It is often the case that a manager is unable to be identified for these areas due to departments and local governments being unable to commit. This is a particular gap in the framework which needs to be addressed.

5.5.4 Protection of conservation significant flora and ecological communities

Certain ecological communities and flora species are afforded special protection by the State Minister for Environment or under legislation. Native plants (flora) can be listed as Specially Protected under the WC Act and published under Schedule 1 of the Wildlife Conservation (Rare Flora) Notice (which may also be referred to as Declared Rare Flora) if they are considered to be:

- under identifiable threat of extinction;
• rare; and/or
• otherwise in need of special protection.

The State Minister for Environment may list an ecological community as being threatened if the community is presumed to be totally destroyed or at risk of becoming totally destroyed. When an ecological community is endorsed as threatened it is assigned one of the following rankings; Presumed Totally Destroyed, Critically Endangered, Endangered or Vulnerable. When a species is nominated as Threatened, it is assigned a status of Critically Endangered, Endangered or Vulnerable.

Species or ecological communities that may be threatened or near threatened, but are data deficient, and have not yet been adequately surveyed to be listed under Schedule 1 of the Wildlife Conservation (Rare Flora) Notice, are added to the Priority Flora List or regarded as Priority Ecological Communities (PECs) under one of the Priority levels 1-5. A full description of State listings and rankings is provided in Appendix E.

5.5.5 Management of wetlands of the Swan Coastal Plain

A wetland is defined in Schedule 5 of the EP Act as ‘an area of seasonally, intermittently or permanently waterlogged or inundated land, whether natural or otherwise, and includes a lake, swamp, marsh, spring, dampland, tidal flat or estuary’.

EPA Position Statement No 4: Environmental Protection of Wetlands (EPA 2004) recognises the following significant environmental values and function of wetlands:

• Primary production;
• Recreational and landscape amenity;
• Hydrological balance;
• Water quality protection; and
• Wildlife habitat.

In a more recent document, Environmental Guidance for Planning and Development (EPA 2008c), the EPA distinguished between ecosystem and human use values. Ecosystem values recognised were high biological diversity and productivity compared to other ecosystems and provision of habitat for rare or Threatened communities or species, or species of restricted or unusual distribution. Examples of human use values include: landscape amenity, cultural and spiritual value for indigenous and non-indigenous people (a wetland may foster a sense of place or other positive personal experience) and social opportunities, for example, a meeting place or site for a family picnic.

Identification and delineation of a wetland is reliant upon characteristics of hydrology, hydric soils and wetland vegetation (Hill et al. 1996). On the Swan Coastal Plain, wetlands are recognised though their listing in the Geomorphic Wetlands Swan Coastal Plain dataset (Figure 5-3). This dataset has been recognised and endorsed by the EPA as the most comprehensive wetland mapping, classification and evaluation work on the Swan Coastal Plain and is identified and utilised by the EPA and DoP as a basis to guide planning and decision making. Parks and Wildlife is the custodian of the dataset and is responsible for maintaining and updating the information within it.

The EPA considers wetlands in terms of the three broad wetland management categories: Conservation (CCWs), Resource Enhancement (REW s) and Multiple Use (Table 5-1). The Geomorphic Wetlands
Swan Coastal Plain dataset attributes a management category to each wetland (or parts of wetlands where this is more appropriate).

Table 5-1: Wetland management categories

<table>
<thead>
<tr>
<th>Category</th>
<th>General description and management objective in EPA Guidance Statement No. 33</th>
</tr>
</thead>
</table>
| Conservation        | Conservation category wetlands support a high level of attributes and functions and are the highest priority wetlands. The objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including:  
  • reservation in national parks, crown reserves and State owned land;  
  • protection under Environmental Protection Policies; and  
  • wetland covenanting by landowners.  
  No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate. The EPA urges that all Conservation category wetlands and appropriate buffers are fully protected. Schemes and proposals that are likely to lead to a significant adverse impact on these wetlands are likely to be formally assessed by the EPA. |
| Resource Enhancement| Resource enhancement wetlands may have been partially modified, but still support substantial ecological attributes and functions. They are priority wetlands and the ultimate objective is to manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category wetlands, and rehabilitation is encouraged. Restoration to Conservation category wetlands can be achieved by restoring wetland function, structure and biodiversity. Protection is recommended through a number of mechanisms. The EPA urges that all reasonable measures are taken to minimise the potential impacts on Resource enhancement wetlands and appropriate buffers. |
| Multiple Use        | Multiple Use Wetlands have few remaining important attributes and functions. The use, development and management of these wetlands should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare. The EPA urges that all reasonable measures are taken to retain the wetland’s hydrological functions (including on-site water infiltration and flood detention) and, where possible, other wetland functions. |

Whilst the EPA identifies the need for appropriate buffers for CCWs and REWs, there is currently no endorsed methodology for their determination. This presents a key gap in the current management arrangements for protection of wetlands and a consistent approach to this is required.

Wetlands of international importance are Ramsar wetlands designated under Article 2 of the Ramsar Convention or declared by the Commonwealth Minster for the Environment to be a declared Ramsar wetland under the EPBC Act. There are three Ramsar wetlands within the Advice Area; Becher Point Wetlands, Forrestdale and Thomson Lakes; and the Peel-Yalgorup System of wetlands. Descriptions of and potential impacts to these wetlands are addressed in the Commonwealth IAR and generally not further discussed in the State IAR.
Figure 5-3: Geomorphic wetlands of the Swan Coastal Plain wetland mapping in the Advice Area

Legend
- Advice Area
- CCWs
- REWs
- MUWs

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: DPaW
Prepared by: SM Date: 18/11/2015
5.5.6 Regulation of vegetation clearing

It is an offence under the EP Act to clear native vegetation unless the clearing is undertaken in accordance with a clearing permit, or an exemption applies. Clearing in accordance with a subdivision approval under the P&D Act is exempt from the requirement for a clearing permit. The decision to issue a clearing permit must take into account any comments received on the application, ensure the permit is consistent with any Environmental Protection Policy issued by the Minister for Environment and have regard to the clearing principles and any relevant Town Planning Scheme, Statement of Planning Policy and/or Local Planning Strategy.

The clearing principles state that native vegetation should not be cleared if:

- it comprises a high level of biological diversity;
- it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia;
- it includes, or is necessary for the continued existence of, rare flora;
- it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community;
- it is significant as a remnant of native vegetation in an area that has been extensively cleared;
- it is growing in, or in association with, an environment associated with a watercourse or wetland;
- the clearing of the vegetation is likely to cause appreciable land degradation;
- the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area;
- the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water; or
- clearing the vegetation is likely to cause, or exacerbate, the incidence or intensity of flooding.

5.5.7 Management of indirect impacts

The management of indirect impacts to flora and vegetation is achieved on a site specific basis, through processes including:

- the land planning process under the P&D Act including the setting of conditions during structure planning and subdivision;
- Part V processes under the EP Act, including native vegetation clearing permit processes;
- Approvals under the Mining Act 1978; and
- Local Government processes.

Application of measures to manage environmental aspects of development is a standard part of the development approval/permitting processes at the State level. Mitigation measures include (among other things):

- Appropriate supporting investigations and studies prior to development to inform planning and design of projects to reduce environmental risk (e.g. groundwater and acid sulfate soil investigations).
• Appropriate planning and design of projects according to policy and guidance to reduce potential impacts (e.g. water sensitive urban design measures in urban and industrial development to reduce water quality and erosion issues).

• Management measures to be applied during construction activities to reduce the risk of impacts occurring (e.g. dieback and weed hygiene measures).

• Ongoing activities to address potential indirect impacts of development, including:
  o fragmentation and edge effects;
  o introduction of weeds and/or pests;
  o issues associated with dust;
  o changed fire regimes;
  o disturbance related to increasing numbers of people; and
  o alterations to groundwater and/or surface water.

5.6 AVOIDANCE TO DATE

Significant avoidance of impacts to environmental factors was undertaken during development of the sub-regional frameworks (see Section 2.2). A description of how avoidance processes conducted during the development of these frameworks has provided specific benefits for flora and vegetation is presented in this section. The majority of avoidance relevant to flora and vegetation values occurred through revision of the urban, industrial and BRM footprints.

The proposed development footprint, in particular the proposed urban expansion areas, was subject to a number of iterations and incorporated a footprint planning phase that considered, along with planning matters, the potential impacts to environmental factors and the measures that could be put in place to protect/avoid these assets. Footprint boundaries were adjusted to avoid environmental assets and to incorporate land that is better suited for development or might provide an improved development footprint. The process of refining the initial overall footprint (referred to as EIA1), in particular reducing the quantity of urban expansion land, provided significant benefits for flora and vegetation values. More than 3,400 ha of remnant vegetation was avoided in this process, with the proposed urban and industrial expansion areas affecting approximately 2,735 ha compared to over 6,148 ha in EIA1. This avoidance translated to avoidance of impact to most flora and vegetation values.

The refinement of EIA1 to the proposed development footprint also resulted in some individual significant species or areas of flora or vegetation being subject to a greater impact than under EIA1. This is because, at each successive refinement, analysis of future dwelling supply was conducted to evaluate the capability of the footprint to still deliver the required housing supply for 3.5 million people. Although the initial overall impact of urban expansion areas was reduced, some new areas were added and other area were relocated or had their boundaries realigned to result in the best possible outcome for flora and vegetation values overall.

The specific changes in impact to flora and vegetation values due to the refinement of EIA1 to the proposed development footprint are as follows:

• RSNAs:
  o Reduced impact to Peel RSNAs by 41 sites and 382 ha;
Increased impact to Bush Forever by seven sites and 81 ha;

- Wetlands:
  - Reduced impact to CCWs by 82 occurrences and 292 ha;
  - Reduced impact to REWs by 45 occurrences and 510 ha;

- Vegetation complexes:
  - Complete avoidance of four vegetation complexes within the urban expansion footprint: Dardanup, Cannington, Yanga and Yarragil 1 - Yg1 complexes (total area avoided 70 ha);
  - Reduced impact to 18 vegetation complexes, with 3,413 ha no longer intersected by the urban and industrial expansion footprint;
  - Increased impact to four vegetation complexes, with an additional 43 ha intersected by the urban expansion footprint: Reagan, Bassendean North – Transition, Pinjar and Darling Scarp;

- Conservation significant ecological communities:
  - Reduced impact to the PEC Banksia ilicifolia woodlands by one occurrence;
  - Increased impact to the Banksia attenuata woodland over species rich dense shrublands Threatened Ecological Community (TEC) by one occurrence and 1 ha;

- Conservation significant flora
  - Reduced impact to the Threatened flora species Synaphea sp. Pinjarra Plain by seven populations and 0.04 ha of known and supporting habitat; and
  - Avoidance of the Priority flora species Phyllangium palustre; and
  - Reduced potential impact to Tripterococcus paniculatus by one record.

In regards to avoidance measures, of particular note is the decision to exclude the East Keralup urban development from future planned development. Key values retained through this exclusion include:

- several areas of bushland designated as Peel RSNAs by the EPA Environmental Protection Bulletin No. 12, December 2010, which will be retained in addition to the a 588 ha Bush Forever site there, in Degraded to Very Good condition and part of the proposed extension of the Peel-Yalgorup Ramsar site;
- an area of the Serpentine River and approximately 500 ha of a CCW and river floodplain, located within an 890 ha area to be set aside as Regional Open Space;
- examples of the Bassendean Central and South complex, which has less than 30 per cent of its pre-European extent in the Advice Area remaining, and the Serpentine River complex, which has less than 10 per cent of its pre-European extent in the Advice Area remaining; and
- occurrences of three Priority flora species.

With regard to the BRM footprint, Section 2.2.3 of this document describes in detail the avoidance through planning which has occurred to date. BRM master planning resulted in approximately 13,000 ha of native vegetation in designated BRM nodes being avoided and designated as exclusion areas in which no BRM extraction can occur. Impacts discussed in Section 5.7 relate only to Future Resource Extraction Areas and Further Investigation Areas (Section 2.2.3).
The specific changes in impact to flora and vegetation values from the avoidance in the BRM footprint are as follows:

- **RSNAs:**
  - Reduced potential impact to Bush Forever by 34 sites, 8,894 ha;
  - Reduced potential impact to Peel RSNAs by eight sites and 815 ha;
  - Reduced potential impact to System 6 by one site and 30 ha;

- **Wetlands:**
  - Reduced potential impact to CCWs by 28 sites and 331 ha;
  - Reduced potential impact to REWs by five sites and 45 ha;

- **Vegetation complexes:** Reduced potential impact to seven vegetation complexes (each with less than 30 per cent of their pre-European extent in the Advice Area remaining), with a total of 908 ha no longer intersected by the BRM footprint across these seven vegetation complexes;

- **Conservation significant ecological communities:**
  - Reduced potential impact to the TEC *Melaleuca huegelii - Melaleuca acerosa* (currently *M. systena*) shrublands on limestone ridges (Gibson et al. 1994 type 26a) by 18 occurrences and 47 ha;
  - Reduced potential impact to the PEC *Banksia ilicifolia* woodlands by one occurrence (point location); and

- **Conservation significant flora:** One record each of the Priority flora species *Amanita carneiphylla* (P2) and *Baeckea* sp. Limestone (N. Gibson & M.N. Lyons 1425) (P1) was avoided.

### 5.7 ANALYSIS OF POTENTIAL IMPACTS

#### 5.7.1 Future avoidance processes

Future likely avoidance within the proposed urban, industrial and rural residential footprints will occur through retention of key areas designated during land use planning. Future likely avoidance for infrastructure footprint will occur through refinement of the footprint.

The proposed urban, industrial and rural residential development footprints will be subject to more detailed planning, including the identification of areas to avoid ensuring retention of environmental values. This process will result in the designation of areas of open space to retain or protect environmental values consistent with environmental policy and legislation. The actual retention/protection of these values in future will be implemented through the State’s planning processes (Section 5.5.3). Through these processes it is currently estimated 2,200 ha of remnant vegetation is likely to be avoided within the proposed urban, industrial and rural residential expansion areas. This 2,200 ha is likely to cover a range of environmental values including regionally significant vegetation, CCWs, threatened species and communities and under-represented vegetation complexes.

Future avoidance planning through the process outlined in Action Plan C for infrastructure has the potential to deliver substantial reduction in impacts to flora and vegetation. Refinement of location will be undertaken to avoid or minimise impacts. However, this reduction is unable to be estimated at this stage.
5.7.2 Levels of protection of environmental values

The interplay between security of land tenure, applicable legislative protections, and management regimes (including resourcing, expertise and community capacity) is important to achieve conservation outcomes. While inclusion of land within the formal reserve system (National Park, Nature Reserve, Conservation Park) accords the highest level of protection, zoning and associated development controls under the statutory planning regime provide a complementary supportive mechanism in appropriate circumstances, and off-reserve conservation through formalised efforts on private lands also plays an important role.

Information on land tenure, ownership, zoning and purpose has been used in order to classify land based on the level of protection it affords, or conversely the development risk that this may represent. This analysis has been used in order to provide context for the impacts that have been estimated as a result of the proposed development. Seven levels of protection have been defined.

The impact analyses provided in Section 5.7.3 to 5.7.7 include assessments against the various land classes in order to compare levels of protection or development risk that a particular environmental value may be subject to. The assessments provide the extent of each flora and vegetation value within each of the following seven levels:

- **Level 1**: Protected areas equivalent to IUCN I-IV or within land managed by Parks and Wildlife. These areas are retained and managed for conservation. They have the highest level of security and are considered protected for the purpose of this assessment.

- **Level 2**: Bush Forever or Crown reserve with conservation listed in its purpose. These areas are intended for protection. Where they are reserved and managed for conservation they are considered to provide good long term outcomes. A proportion of these sites have the intent for protection but not yet the reservation or management status.

- **Level 3**: Reserved in a region scheme for ‘Parks and Recreation’ or ‘Regional Open Space’. These areas are set aside at the Region Scheme level for conservation and/or recreation and are broadly sympathetic to the retention of vegetation.

- **Level 4**: Land potentially sympathetic to conservation within a Local Structure Plan and may be zoned Public Open space, Conservation, State Forest or Recreation/Conservation in Local Planning Schemes. Also includes Crown reserves with recreation listed in its purpose. Similar to level 3, these areas are set aside at the local planning level for conservation and/or recreation and are broadly sympathetic to the retention of vegetation.

- **Level 5**: Land which falls outside of a class of action footprint and outside of levels 1 – 4. These areas represent the remaining land within the Advice Area. Predominately comprised of rural zoned land it is broadly expected that some level of decline in vegetation will occur over time, but also that large portions will remain.

- **Level 6**: State owned land within the development footprint or within an existing zoned urban or industrial area. These areas are likely to be developed.

- **Level 7**: All other land within the development footprint or within an existing zoned urban or industrial area. These areas are likely to be developed.
5.7.3 Regionally significant natural areas

Potential impacts and approach to the analysis

The main potential impact to RSNAs is clearing associated with the development of the footprints. The number and area of RSNAs intersected by the proposed future development has been calculated and reported in this Section. Only clearing impacts of >10 m² (0.001 ha) have been reported, to exclude errors due to spatial scale of mapping and provide focus on potentially significant impacts.

The potential impacts to RSNAs in the Advice Area as a result of clearing associated with the proposed development are presented in Table 5-2 and Figure 5-5. The proposed development footprint intersects 386 of the 1,136 RSNAs in the Advice Area (34 per cent), over an area of 3,572 ha (2 per cent of the total area of RSNAs in the Advice Area). Although the area affected is relatively minor in relation to the number of sites affected, if all of this area was developed individual sites may be fragmented by the proposed footprint, particularly components of the proposed infrastructure footprint such as roads and rail. The likelihood of further avoidance to reduce the impacts reported is discussed under Management and mitigation.

In order to provide context for potential cumulative impacts to RSNAs, a breakdown of the area of RSNAs currently occurring within the Advice Area against their varying existing levels of protection (Section 5.7.2) is reported in Figure 5-4.

Approximately 57 per cent of Bush Forever, Peel RSNAs and System 6 sites within the Advice Area (42, 46 and 80 per cent respectively) are held in IUCN I-IV secure conservation tenure (Figure 5-4). A further 35 per cent are on land sympathetic to conservation (levels 2, 3 and 4). This represents a large proportion of the total RSNAs, indicating that the biggest risk to RSNAs within the Advice Area is likely to be from fragmentation rather than broad scale clearing.

Figure 5-4: Protection levels (1-7) for RSNAs in the Advice Area
Figure 5-5: Potential Impacts to RSNAs within the Advice Area

Legend
- Advice Area
- Intersected RSNAs

RSNAs
- Bush Forever
- Peel RSNAs
- System 6

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: EPA (June 2015), DoP
Prepared by: SM Date: 17/11/2015
**Bush Forever**

The proposed development footprint intersects 191 of the 282 Bush Forever sites in the Advice Area (68 per cent), over 2,743 ha (4 per cent of the total area of Bush Forever sites in the Advice Area). The main impact to Bush Forever sites is the proposed infrastructure and, to a lesser extent, urban footprints (Table 5-2).

The proposed infrastructure footprint comprises water, power, rail and road infrastructure. The majority of potential impacts to Bush Forever sites are due to road infrastructure, predominantly existing road reserves, which intersect 111 Bush Forever sites over 432 ha. Proposed rail infrastructure accounts for the lowest potential impact to Bush Forever sites; however, in its interim strategic advice, the EPA (2015a) raised concerns about the alignment of one specific component of the proposed rail footprint, the East Wanneroo Rail, and its potential impact to the following Bush Forever sites:

- 398 – Chitty Road Bushland;
- 382 – Lake Pinjar;
- 384 – Neerabup Lake; and
- 383 – Neerabup National Park.

The current proposed East Wanneroo Rail alignment would result in clearing of 5-10 ha of each these Bush Forever sites and would fragment the sites through the centre of a large portion of sites 384 and 383 and along the edge of sites 398 and 382. This alignment would be reviewed through the process of further refinement described in Action Plan C.

**Peel RSNAs**

The proposed development footprint intersects 184 of the 811 occurrences of Peel RSNAs in the Advice Area (23 per cent), over 561 ha (2 per cent of the total area of Peel RSNAs in the Advice Area). The main potential impact to Peel RSNAs is, on an area basis, the proposed rural residential footprint (155 ha) and, on a site basis, the proposed infrastructure footprint (142 occurrences) (Table 5-2).

**System 6**

The proposed development footprint intersects 11 of the 43 System 6 areas in the Advice Area (26 per cent), over 268 ha (0.5 per cent of the total area of System 6 areas in the Advice Area). The main impact to System 6 is, on an area basis, the proposed BRM footprint (200 ha) and, on a site basis, the proposed infrastructure and rural residential footprints (nine and six sites respectively; Table 5-2). The urban and industrial footprints do not intersect impact System 6 areas.
### Table 5-2: Potential impacts to RSNAs in the Advice Area before and after consideration of further likely avoidance

<table>
<thead>
<tr>
<th>Type</th>
<th>No. in Advice Area (area in hectares shown in parentheses)</th>
<th>RSNAs intersected by the proposed development footprint (area in hectares shown in parentheses)</th>
<th>Total¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BRM</td>
<td>Infrastructure</td>
</tr>
<tr>
<td><strong>Bush Forever</strong></td>
<td></td>
<td>26</td>
<td>158 (1,444)</td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>282 (63,714)</td>
<td></td>
<td>Likely to remain unchanged</td>
</tr>
<tr>
<td>Indicative further avoidance</td>
<td>282 (63,714)</td>
<td>26 (266)</td>
<td>158 (1,444)</td>
</tr>
<tr>
<td><strong>Peel RSNAs</strong></td>
<td></td>
<td>14</td>
<td>142 (99)</td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>811 (24,814)</td>
<td></td>
<td>Likely to remain unchanged</td>
</tr>
<tr>
<td>Indicative further avoidance</td>
<td>811 (24,814)</td>
<td>14 (39)</td>
<td>142 (99)</td>
</tr>
<tr>
<td><strong>System 6</strong></td>
<td></td>
<td>1</td>
<td>9 (43)</td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>43 (55,209)</td>
<td></td>
<td>Likely to remain unchanged</td>
</tr>
<tr>
<td>Indicative further avoidance</td>
<td>43 (55,209)</td>
<td>1 (200)</td>
<td>9 (43)</td>
</tr>
</tbody>
</table>

¹ Totals are not cumulative across footprints, as potential impacts may relate to the same RSNAs.
**Management and mitigation**

The analysis presented is based on intersection with the broad footprints and indicates potential impacts before consideration of further avoidance. Actual direct impacts will be reduced through statutory planning for urban, industrial and rural residential footprints and conservation of environmental values in areas of public open space. A commitment has been made to finalise the retention, protection and acquisition of Bush Forever sites as part of this process.

Within the infrastructure footprint, the intersect areas provide an early indication of the scale of potential impacts but will be subject to refinement of locations to avoid or minimise impacts, as described in Action Plan C. For BRM, the impacts presented represent the likely final outcomes (i.e. extent of clearing/impact), as detailed planning/master planning to avoid and minimise impacts has already taken place for BRM nodes.

The alignment of East Wanneroo Rail is indicative only at this stage and will be subject to detailed planning and design, which will determine the final location and design of individual infrastructure proposals. The EPA (2015a) identified this as an opportunity for impacts to be further avoided and mitigated before consideration is given to offsets. Infrastructure Action Plan C describes the process to achieve this and any impacts to Bush Forever sites from infrastructure would only be proposed if it is demonstrated there are no reasonable and practicable alternatives.

In addition, DoP has undertaken a preliminary assessment within the urban, industrial and rural residential expansion areas of areas likely to be prioritised for retention through future statutory planning processes. Based on this preliminary assessment it is estimated that a further 227 ha of Peel RSNAs are likely to be avoided through this process.

In spite of further avoidance, the potential for impacts to RSNAs warrants further commitments to ensure the EPA objectives can be met.

In the EPA’s interim strategic advice, several RSNAs were presented as examples of iconic areas that are inadequately protected in the Advice Area. These were highlighted as examples of where early action, such as acquisition to consolidate areas or increasing reservation status, would optimise benefits. One of these RSNAs identified was Anstey Keane dampland, a 366 ha Bush Forever site (No. 342) that contains damplands and uplands, and supports communities representative of the eastern side of the Swan Coastal Plain, CCWs and significant fauna. The proposed development footprint does not intersect this site; however, the site is a good example of the types of areas that would benefit from measures to consolidate significant areas or increase the reservation status of Bush Forever sites across the Advice Area.

Based on the EPA’s interim strategic advice, a commitment has been developed to address the management of RNSAs with the aim of maximising the number of RSNAs formally protected and maintained through appropriate conservation management strategies and increased viability through the improvement of degraded areas and re-establishment of ecological linkages. The commitment will be delivered under the conservation program of the Strategic Conservation Plan and represents an offset for the potential loss of RSNAs through the proposed future development and potential fragmentation caused by the footprints.

Through the conservation program, a number of sites are to be acquired upfront, with a rolling offsets plan to include continual acquisition/protection as part of the ongoing conservation program. This
strategy will draw on DoP review of Bush Forever, as well as agency advice on priority sites for acquisition and appropriate mechanisms for protection.

Commitments within the Commonwealth IAR and Action Plan F identify the establishment of the Peel Regional Park and extension of the Yalgorup and Yanchep National Parks among those sites to be targeted for immediate action.

**Commitment:** Protect, maintain and enhance Regionally Significant Natural Areas (RSNAs) through the following actions:

- Finalise the retention, protection and acquisition of the Bush Forever Program, and implement management, where required.
- Develop and implement an overall strategy for the conservation and management of RSNAs in the Perth and Peel regions that identifies existing protected sites and sites to be formally protected over time with an indication of the proposed conservation levels and associated management responsibilities.

### 5.7.4 Wetlands

Given the strategic nature of this assessment, impacts to CCWs and REWs only (i.e. excluding Multiple Use Wetlands) have been considered. There are 1,891 CCWs in the Advice Area with a total area of 44,987 ha, and 1,070 REWs with a total area of 12,102 ha (Table 5-3 and Figure 5-3).

In the Perth and Peel regions there are 16 wetlands or wetland systems listed on the Directory of Important Wetlands in Australia: Barraghup Swamp, Becher Point Wetlands, Booragoon Swamp, Brixton Street Swamps, Ellen Brook Swamps System, Forrestdale Lake, Gibbs Road Swamp System, Herdsman Lake, Joondalup Lake, Lake McLarty System, Loch McNess System, Peel-Harvey Estuary, Perth Airport Woodland Swamps, Spectacles Swamp, Swan-Canning Estuary, Thompsons Lake, and Yalgorup Lakes System. These wetlands are captured in the assessment of potential impacts to CCWs or, if also listed as a Ramsar site, are addressed in the Commonwealth IAR.

**Potential impacts and approach to the analysis**

The main potential impacts to wetlands are clearing associated with the development of the footprints and degradation as a result of changes to surface water and/or groundwater. This section addresses impacts from clearing only; potential impacts due to changes to surface water and/or groundwater are addressed in Chapter 7 (Impacts to Hydrological Processes and Inland Waters Environmental Quality). The number and area of wetlands intersected by the proposed future development has been calculated and reported in this Section. Only clearing impacts of >10 m² (0.001 ha) have been reported, to exclude errors due to spatial scale of mapping and provide focus on potentially significant impacts.

In order to provide context for potential cumulative impacts to wetlands, the total area of CCWs and REWs within the Advice Area according to their varying levels of existing protection (Section 5.7.2) has been estimated (Figure 5-6).

Approximately half of all wetlands (43 per cent of CCWs and 52 per cent of REWs) sit within level 5 in the levels of protection of environmental values. This level represents land outside existing or proposed development footprints and also outside land sympathetic to conservation. Most of these wetlands are likely within rural zoned areas. This shows that a large proportion of the wetlands in the Advice Area will...
be unaffected by any clearing or avoidance related to the future proposed development. It is estimated 27 per cent of CCWs and just 8 per cent of REWs are within secure conservation tenure. An additional 28 per cent and 22 per cent respectively are within land sympathetic to conservation.

Figure 5-6: Protection levels (1-7) for CCWs and REWs in the Advice Area

![Protection levels graph]

**Conservation category wetlands**

The potential for impacts to CCWs in the Advice Area as a result of clearing associated with the proposed development is presented in Table 5-3 and Figure 5-7. The proposed development footprint intersects 461 of the 1,891 CCWs in the Advice Area (24 per cent of CCW occurrences). Although this is a large number of CCWs, many are small and in total area they account for 2.3 per cent of the area of CCWs in the Advice Area (1,038 ha of 44,981 ha).

An additional 165 CCWs are located within 50 m of the proposed development footprint and considered to have potential for indirect impacts through affecting what would likely be a minimum buffer required for these wetlands noting the State is still to finalise a formal wetland buffer policy.

Of the proposed future development it is the proposed infrastructure footprint, which intersects 330 CCWs over 408 ha with an additional 154 CCWs located within 50 m of the proposed infrastructure footprint, that has the largest proportion of impacts (Table 5-3). The proposed infrastructure footprint comprises water, power, rail and road infrastructure. The majority of potential impacts to CCWs are due to road infrastructure, predominantly existing road reserves, which intersect 158 CCWs with a total area of 151 ha within the footprint.

In its interim strategic advice (EPA 2015a), the EPA raised concerns about the alignment of one specific component of the proposed rail footprint, the East Wanneroo Rail, and its potential impact to a number of Bush Forever sites. Two of these Bush Forever sites contain CCWs which are intersected by this
alignments: Chitty Road Bushland (Bush Forever Site No. 398) and Lake Pinjar (Bush Forever Site No. 382).

**Resource enhancement wetlands**

The potential impacts to REWs in the Advice Area as a result of clearing associated with the proposed development are presented in Table 5-3 and Figure 5-8. The proposed development footprint intersects 364 of the 1,070 REWs in the Advice Area (34 per cent), over an area of 1,494 ha (11.7 per cent of the total area of REWs in the Advice Area). An additional 97 REWs are within 50 m of the proposed development footprint. REWs are not afforded the same level of protection as CCWs through existing environmental policy and are therefore could be considered to be at greater risk of impact from the proposed future development.

The future development with the highest potential for impacts to REWs are the proposed urban and infrastructure footprints. The proposed urban footprint intersects 69 REWs over 463 ha, with an additional 25 REWs located within 50 m. By comparison the infrastructure footprint intersects 254 REWs over 347 ha, with an additional 101 REWs located within 50 m of the footprint\(^4\) (Table 5-3). The majority of potential impacts to REWs are due to road infrastructure, predominantly existing road reserves, which intersect 113 REWs over 151 ha.

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\(^4\) This number exceeds the total number of REWs within 50 m of the proposed development footprint because some of the 101 REWs located within 50 m of the infrastructure footprint are intersected by other footprints (BRM, urban, industrial and/or rural residential).
Figure 5-7: Potential Impacts to CCWs within the Advice Area

Legend
- Advice Area
- CCWs
- Intersected CCWs

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: EPA (June 2015)
Prepared by: SM Date: 17/11/2015
Figure 5-8: Potential Impacts to REWs within the Advice Area

Legend
- Advice Area
- REWs
- Intersected REWs

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: EPA (June 2015)
Prepared by: SM  Date: 29/10/2015
### Table 5-3: Potential impacts to wetlands in the Advice Area before and after consideration of further likely avoidance

<table>
<thead>
<tr>
<th>Wetland</th>
<th>No. in Advice Area (area in hectares shown in parentheses)</th>
<th>Wetlands intersected by the proposed development footprint (area in hectares shown in parentheses)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>BRM²</td>
</tr>
<tr>
<td>CCWs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>1,891 (44,981)</td>
<td>6 (2)</td>
</tr>
<tr>
<td>Additional wetlands within 50 m</td>
<td>10</td>
<td>154</td>
</tr>
<tr>
<td>Indicative further avoidance</td>
<td>Likely to remain unchanged</td>
<td>Refinement of location to avoid or minimise impact</td>
</tr>
<tr>
<td>REWs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>1,070 (12,768)</td>
<td>7 (27)</td>
</tr>
<tr>
<td>Additional wetlands within 50 m</td>
<td>13</td>
<td>101</td>
</tr>
<tr>
<td>Indicative further avoidance</td>
<td>Likely to remain unchanged</td>
<td>Refinement of location to avoid or minimise impact</td>
</tr>
</tbody>
</table>

¹ Totals are not cumulative as impacts across footprints may relate to the same wetland.
Management and mitigation

The commitments made for RSNAs will contribute to the protection of a large number of CCWs and REWS, and importantly, those that occur within high quality and large areas of remnant vegetation.

As with RSNAs, the analysis presented indicates potential impacts based on intersection with the broad footprints before consideration of further avoidance. Actual direct impacts will be reduced through further avoidance achieved during statutory planning for urban, industrial and rural residential footprints and conservation of environmental values in areas of public open space. A commitment has been made to avoid all CCWs within urban, industrial and rural residential expansion areas. In regards to cumulative impacts, it should be noted that Action Plan F also provides a commitment to avoid all CCWs within existing zoned urban, industrial and rural residential areas.

Within the infrastructure footprint, the intersect areas provide an early indication of the scale of potential impacts but will be subject to refinement of locations to avoid or minimise impacts, as described in Action Plan C. For BRM, the potential impacts, which are relatively small compared to other development, represent the likely final outcomes (i.e. extent of clearing/impact), as detailed planning/master planning to avoid and minimise impacts has already taken place for BRM nodes.

REW's are currently not afforded the same level of protection as CCWs and management objectives are often unclear. As a result a commitment has been made to minimise impacts to REW's within urban and industrial areas through prioritisation of those to be retained.

DoP has undertaken a preliminary assessment within the urban, industrial and rural residential expansion areas of areas likely to be prioritised for retention through future statutory planning processes. Based on this preliminary assessment it is estimated that 86 REW's are likely to be avoided within these areas. This estimate does not cover areas within the Central sub-region where urban consolidation activities are proposed and further avoidance could be expected in these areas.

In addition, a wetland buffer policy will be finalised and implemented with the result that retention of an appropriate buffer, as determined through the policy will be required for all wetlands to be retained within urban, industrial and rural residential areas.

Maintenance of hydrological regimes is crucial to protection of wetlands and especially relevant in a drying climate. This aspect of wetlands management is discussed in Chapter 7 (Impacts to Hydrological Processes and Inland Waters Environmental Quality).

The Commonwealth IAR and Action Plan F provide a range of commitments aimed towards the management and mitigation of impacts to Ramsar wetlands. These include acquisition of surrounding land, management of groundwater levels and improved monitoring and reporting, among other actions. Refer to Action Plan F for further detail.

The potential for impacts to wetlands to occur, in particular direct impacts to CCWs, warrants further commitments to ensure the EPA objectives are met. In response to this, offsets will be delivered through implementation of the conservation program detailed in the Strategic Conservation Plan, including those detailed in Section 5.7.8. The extent of wetland offsets to be delivered will depend on the final wetlands impacts determined following further efforts to avoid and minimise impacts.
Commitment: Protect the values of conservation category wetlands through:

- development and implementation of a new wetland buffer policy for wetlands to be retained through the land planning process;
- avoiding all CCWs within urban, industrial and rural residential areas and include an appropriate buffer determined in accordance with the above policy; and
- protection of the hydrological regime and water quality of these wetlands through the measures described in the relevant commitment under the Water factor theme.

Commitment: Minimise impacts to REWs by determining a list to be retained within the Advice Area which will be treated the same as for CCWs (as per the above commitment). This will be achieved through undertaking a review of all REWs intersected by the urban and industrial classes of action, seeking to minimise impacts on REWs through prioritisation based on:

- those that are contiguous with or form (a degraded) part of a CCW; and
- supporting known habitat of listed threatened species and migratory species; and
- likely success of future rehabilitation and elevation of management category to CCW; and
- likely ability to withstand the effects of climate change.

5.7.5 Vegetation complexes

Vegetation complex mapping of the Swan Coastal Plain was completed by Heddle et al. (1980) and Havel and Mattiske (2000) to describe vegetation of the Darling System (System 6), and took into account soil, landform and floristics. More detailed studies of floristic communities present on the southern Swan Coastal Plain were completed by Gibson et al. (1994), and for Bush Forever and the Swan Bioplan Project. The delineation of vegetation complexes is based on the concept of a series of plant communities forming regularly repeating complexes associated with a particular landform soil unit as identified by Churchward and McArthur (1980) (Government of Western Australia 2000). In this mapping the plant communities may occur in more than one complex but the relative proportions of the communities in the complex are different (Government of Western Australia 2000).

Forty-four vegetation complexes, as mapped by Heddle et al. (1980) and Havel and Mattiske (2000), occur in the Advice Area (Figure 5-9 and Figure 5-10). A full list of these vegetation complexes is provided in Appendix B. Some vegetation complexes are poorly represented and poorly reserved, with some already below desired thresholds for loss of ecological communities or targets for retention on the Swan Coastal Plain (e.g. 10 per cent reservation target within Bush Forever). Some areas of these vegetation complexes overlap with areas identified as regionally significant natural areas (RSNAs) (e.g. Bush Forever) and/or conservation reserves. The EPA’s interim strategic advice documents those vegetation complexes where 10 per cent or less of the complex remains vegetated and also those where greater than 10 per cent but less than 30 per cent of the complex remains vegetated, within the Swan Coastal Plain IBRA region within System 6 (and part System 1 – South West).
Potential impacts and approach to the analysis

The main potential impact to vegetation complexes is clearing associated with the development of the footprints. The area of each vegetation complex intersected by the proposed future development has been calculated and reported in this Section.

Potential impacts are discussed in detail for vegetation complexes with less than 30 per cent remaining of their pre-European extent in the Advice Area and those for which the predicted future extent in the Advice Area (following clearing associated with the proposed development footprint) is less than 30 per cent of their pre-European extent in the Advice Area.

DoP has undertaken a preliminary assessment within the urban, industrial and rural residential expansion areas of likely viable patches of remnant vegetation to be prioritised for retention through future statutory planning processes. Numbers have been provided which indicate likely minimum avoidance of vegetation complexes based on this preliminary assessment. For the urban footprint, no estimates have been made for likely further avoidance in pre 1996 zoned sites or for urban consolidation activities within the Central sub-region. For this reason the areas of impact from the urban footprint are likely to be further reduced during future statutory planning to below that indicatively shown.

Impact analysis

The proposed development footprint intersects 9,836 ha of remnant vegetation, or about 2.5 per cent of all remnant vegetation within the Advice Area. A total of 38 vegetation complexes are intersected. Potential clearing is highest within the rural residential footprint, followed (in order) by the infrastructure, BRM, urban and industrial footprints.

Table 5-4: Overall impacts to vegetation complexes in the Advice Area before and after consideration of further likely avoidance

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Area of all vegetation complexes intersected by footprints (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BRM</td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>2,057</td>
</tr>
<tr>
<td>Indicative after further avoidance</td>
<td>Likely to remain unchanged</td>
</tr>
</tbody>
</table>

Of the 44 vegetation complexes in the Advice Area, 27 have more than 30 per cent of their pre-European extent in the Advice Area remaining and will not be reduced below 30 per cent as a result of clearing associated with the proposed development footprint. Potential impacts to the 17 remaining vegetation complexes are discussed under the following headings: ‘Vegetation complexes reduced below 30 per cent’, ‘Vegetation complexes currently less than 30 per cent’, ‘Vegetation complexes reduced below 10 per cent’ and ‘Vegetation complexes currently less than 10 per cent’. The potential impacts to these 17 vegetation complexes as a result of clearing associated with the proposed development footprint are summarised in Table 5-5 and represented in Figure 5-11.
Vegetation complexes reduced below 30 per cent

The extent of two vegetation complexes with more than 30 per cent of their pre-European extent in the Advice Area remaining, the Mogumber South and Cottesloe Central and South complexes, may be reduced below 30 per cent as a result of clearing associated with the proposed development footprint. The main potential impact to these two vegetation complexes is from the proposed BRM footprint.

These vegetation complexes currently have 2.2 to 8.8 per cent of their pre-European extent in the Advice Area protected in IUCN I-IV areas and 23 to 25 per cent located in RSNAs (Table 5-6). These numbers indicate that there is strong rationale to increase the area of these vegetation complexes within formal conservation reserves.

Vegetation complexes currently less than 30 per cent

The extent of nine vegetation complexes with less than 30 per cent (but greater than 10 per cent) of their pre-European extent in the Advice Area will be further reduced, but remain greater than 10 per cent, as a result of clearing associated with the proposed development footprint (Table 5-5). These are the Swan, Yanga, Cannington, Karrakatta Central and South, Southern River, Karrakatta North, Bassendean Central and South, Reagan and Pinjar complexes.

The main potential impact to these vegetation complexes is the urban footprint. Of the 578 ha intersected by the urban development footprint, after consideration of DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints (Table 5-5), this is likely to be reduced to 151 ha in proposed urban expansion areas with 26 ha remaining potentially affected in existing pre-1996 zoned urban areas and 399 ha in existing zoned urban consolidation areas within the Central sub-region. There are existing and potential means to ensure further retention and protection of areas of vegetation and habitat within the pre-1996 zoned and existing zoned urban consolidation areas and not all of this area should be assumed to be cleared.

These vegetation complexes currently have between zero and 5.8 per cent of their pre-European extent in the Advice Area protected in IUCN I-IV areas and 6 to 27 per cent located in RSNAs (Table 5-6).

Vegetation complexes reduced below 10 per cent

The current extent of the Forrestfield complex is less than 30 per cent (but greater than 10 per cent) of its pre-European extent in the Advice Area, but will be reduced below 10 per cent as a result of clearing associated with the proposed development footprint (Table 5-5). The main potential impact to this vegetation complex arises from the rural residential footprint. Preliminary assessment of likely future avoidance during statutory planning has not highlighted substantial change in impact and therefore at this stage the reduction of this vegetation complex below 10 per cent is considered likely to occur (Table 5-5). The Forrestfield complex currently has 1.0 per cent of pre-European extent in the Advice Area protected in IUCN I-IV areas and 5.4 per cent located in RSNAs (Table 5-6).

Vegetation complexes currently less than 10 per cent

The extent of four vegetation complexes with currently less than 10 per cent of their pre-European extent in the Advice Area will be further reduced as a result of clearing associated with the proposed development footprint. These are the Guildford, Beermullah, Dardanup and Serpentine River complexes (Table 5-5).

The proposed development footprint intersects 467 ha of the Guildford complex (15 per cent of current extent in the Advice Area). After consideration of DoP’s preliminary assessment of future avoidance
within the urban, industrial and rural residential expansion footprints, the impact is likely to be reduced from 467 ha to 165 ha (5 per cent of current extent in the Advice Area). The main potential impact arises from the infrastructure footprint (Table 5-5), which will also be subject to further refinement of location to avoid or minimise impacts. The Guildford complex currently has 0.4 per cent of its pre-European extent in the Advice Area protected in IUCN I-IV areas and 2.8 per cent located in RSNAs (Table 5-6).

The proposed development footprint intersects 28 ha of the Beermullah complex (6 per cent of current extent in the Advice Area). After consideration of DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints, the impact is likely to be reduced from 28 ha to 11 ha (2 per cent of current extent in the Advice Area). The main potential impact arises from the infrastructure footprint (Table 5-5), which will also be subject to further refinement of location to avoid or minimise impacts. The Beermullah complex currently has 2.1 per cent of its pre-European extent in the Advice Area protected in IUCN I-IV areas and 5 per cent located in RSNAs (Table 5-6).

The proposed development footprint intersects 94 ha of the Dardanup complex (26 per cent of current extent in the Advice Area). After consideration of DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints, the impact is likely to be reduced from 94 ha to 38 ha (10 per cent of current extent in the Advice Area); however, the main potential impact remains the rural residential footprint (Table 5-5). The Dardanup complex is currently not protected in IUCN I-IV areas; however, 5.3 per cent of its pre-European extent in the Advice Area is located in RSNAs (Table 5-6).

The proposed development footprint intersects 35 ha of the Serpentine River complex (3 per cent of current extent in the Advice Area). After consideration of DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints, the impact is likely to be reduced from 35 ha to 30 ha (3 per cent of current extent in the Advice Area). The main potential impact is the infrastructure footprint (Table 5-5), which will also be subject to further refinement of location to avoid or minimise impacts. The Serpentine River complex is currently not protected in IUCN I-IV areas; however, 4.2 per cent of its pre-European extent in the Advice Area is located in RSNAs (Table 5-6).
Figure 5-9: Vegetation Complexes within the Advice Area

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: EPA (May 2015)
Prepared by: SM Date: 17/11/2015
Figure 5-11: Potential Impacts to Vegetation Complexes <30% within the Advice Area

Legend
- Advice Area
- Vegetation Complex <10%
- Vegetation Complex <30%
- Intersected Vegetation Complex

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: EPA (May 2015)
Prepared by: SM Date: 17/11/2015
Table 5-5: Potential impacts to vegetation complexes with <30 per cent of their pre-European extent remaining in the Advice Area

<table>
<thead>
<tr>
<th>Vegetation complex</th>
<th>Pre-European extent in Advice Area (ha)</th>
<th>Current extent in Advice Area (ha)</th>
<th>% of pre-European extent in Advice Area</th>
<th>BRM</th>
<th>Infrastructure</th>
<th>Urban</th>
<th>Industrial</th>
<th>Rural residential</th>
<th>Total all footprints</th>
<th>% of current extent</th>
<th>% of pre-European extent in Advice Area</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Guildford</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
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<td>5.4</td>
<td>2</td>
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<td>135</td>
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<td>To be determined</td>
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<td>4</td>
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<td>165</td>
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<td>3,017</td>
<td>5.1</td>
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</tr>
<tr>
<td><strong>Beermullah</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>28</td>
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<td>11</td>
<td>2.7</td>
<td>432</td>
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<td></td>
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<td></td>
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<tr>
<td><strong>Dardanup</strong></td>
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<td></td>
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</tr>
<tr>
<td>Before further avoidance</td>
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<td>328</td>
<td>7.6</td>
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<tr>
<td>Vegetation complex</td>
<td>Pre-European extent in Advice Area (ha)</td>
<td>Current extent in Advice Area</td>
<td>% of pre-European extent in Advice Area</td>
<td>BRM</td>
<td>Infrastructure</td>
<td>Urban</td>
<td>Industrial</td>
<td>Rural residential</td>
<td>Total all footprints</td>
<td>% of current extent</td>
<td>Predicted future extent in Advice Area</td>
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<td></td>
<td></td>
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<td>Forrestfield</td>
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### Vegetation complex

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<th>Pre-European extent in Advice Area (ha)</th>
<th>Current extent in Advice Area</th>
<th>Area intersected by footprints (ha)</th>
<th>Predicted future extent in Advice Area</th>
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<td></td>
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<td>% of pre-European extent in Advice Area</td>
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<td>Infrastructure</td>
</tr>
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<td>Infrastructure</td>
</tr>
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<tr>
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<td>14.7</td>
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<td>Vegetation complex</td>
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<td>% of pre-European extent in Advice Area</td>
<td>Area intersected by footprints (ha)</td>
<td>Predicted future extent in Advice Area (ha)</td>
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<tr>
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<td>ha</td>
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<td>BRM Infrastructure</td>
<td>Urban</td>
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<td><strong>Southern River</strong></td>
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<tr>
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<tr>
<td>Before and after further avoidance</td>
<td>5,153</td>
<td>997</td>
<td>19.4</td>
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<td><strong>Bassendean Central and South</strong></td>
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<td>137</td>
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<td><strong>Reagan</strong></td>
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<tr>
<td>Before further avoidance</td>
<td>1,639</td>
<td>382</td>
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<td>Indicative after further avoidance</td>
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<td>3</td>
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<td>Vegetation complex</td>
<td>Pre-European extent in Advice Area (ha)</td>
<td>Current extent in Advice Area</td>
<td>Area intersected by footprints (ha)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Predicted future extent in Advice Area</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------------------------------</td>
<td>-------------------------------</td>
<td>-----------------------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td></td>
<td>ha</td>
<td>% of pre-European extent in Advice Area&lt;sup&gt;2&lt;/sup&gt;</td>
<td>BRM</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>Pinjar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>4,893</td>
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<td>Indicative after further avoidance</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Mogumber South</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before and after further avoidance</td>
<td>955</td>
<td>347</td>
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<td>Cottesloe Central and South</td>
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<tr>
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<td>14,621</td>
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<tr>
<td>Indicative after further avoidance</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>1</sup> Values apply to both before and after consideration of further likely avoidance (i.e. no change) unless separate before and after values are provided.

<sup>2</sup> Shaded cells indicate vegetation complexes for which less than 10 per cent remains of their pre-European extent in the Advice Area and/or for which the predicted future extent in the Advice Area (following clearing associated with the proposed development footprint) is less than 10 per cent of their pre-European extent in the Advice Area.
Table 5-6: Area of vegetation complexes in IUCN I-IV areas and RSNAs in the Advice Area and potential retention through future likely avoidance (only vegetation complexes with <30 per cent of their pre-European extent remaining included)

<table>
<thead>
<tr>
<th>Vegetation complex</th>
<th>Predicted future extent in Advice Area before future avoidance</th>
<th>Preliminary assessment of extent after future avoidance</th>
<th>Amount of current extent in Advice Area in IUCN I-IV areas</th>
<th>Amount of current extent in Advice Area within RSNAs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ha</td>
<td>% of pre-European extent</td>
<td>ha</td>
<td>% of pre-European extent</td>
</tr>
<tr>
<td>Guildford</td>
<td>2,716</td>
<td>4.6</td>
<td>3,017</td>
<td>5.1</td>
</tr>
<tr>
<td>Beermullah</td>
<td>416</td>
<td>6.2</td>
<td>432</td>
<td>7.6</td>
</tr>
<tr>
<td>Dardanup</td>
<td>272</td>
<td>6.3</td>
<td>328</td>
<td>7.6</td>
</tr>
<tr>
<td>Serpentine River</td>
<td>1,014</td>
<td>7.9</td>
<td>1,020</td>
<td>7.9</td>
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<tr>
<td>Forrestfield</td>
<td>1,768</td>
<td>9.2</td>
<td>1,859</td>
<td>9.7</td>
</tr>
<tr>
<td>Swan</td>
<td>1,145</td>
<td>11.4</td>
<td>1,155</td>
<td>11.5</td>
</tr>
<tr>
<td>Yanga</td>
<td>679</td>
<td>11.8</td>
<td>756</td>
<td>13.1</td>
</tr>
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<td>Cannington</td>
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<td>12.3</td>
<td>1,864</td>
<td>12.3</td>
</tr>
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<td>5,987</td>
<td>15.6</td>
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<td>14.7</td>
<td>6</td>
<td>14.7</td>
</tr>
<tr>
<td>Southern River</td>
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<td>6,594</td>
<td>16.0</td>
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<td>18.9</td>
<td>974</td>
<td>18.9</td>
</tr>
<tr>
<td>Bassendean Central and South</td>
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<td>19.6</td>
<td>12,738</td>
<td>20.1</td>
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<td>Reagan</td>
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<td>20.1</td>
<td>377</td>
<td>23.0</td>
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<td>1,259</td>
<td>25.7</td>
<td>1,378</td>
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<td>Mogumber South</td>
<td>266</td>
<td>27.8</td>
<td>266</td>
<td>27.8</td>
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<tr>
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<td>12,655</td>
<td>28.8</td>
<td>13,148</td>
<td>30.0</td>
</tr>
</tbody>
</table>

1 Shaded cells indicate vegetation complexes for which the predicted future extent in the Advice Area (following clearing associated with the proposed development footprint) is less than 10 per cent of their pre-European extent in the Advice Area.
Management and mitigation

Some vegetation complexes in the Advice Area are poorly represented reserved and the percentage of some is already below the recommended limit for retention on the Swan Coastal Plain. Four vegetation complexes have less than 10 per cent of their pre-European extent in the Advice Area remaining and a further 11 vegetation complexes have less than 30 per cent remaining. In summary, these vegetation complexes will potentially be further cleared further as a result of the proposed development footprint and may be affected by cumulative impacts from the overall existing and proposed development within the Advice Area. A proportion of these vegetation complexes is already represented within areas identified as RSNAs and/or conservation reserves; however, to meet the EPA’s objective for flora and vegetation and to prevent unacceptable cumulative, and potentially irreversible, loss of biodiversity, a commitment to investigate the retention of the remaining areas of these vegetation complexes is required.

The analysis presented indicates potential impacts before consideration of further avoidance. Further avoidance will be achieved through statutory planning for urban, industrial and rural residential footprints and conservation of environmental values in areas of public open space. A commitment has been made to avoid viable patches of vegetation complexes <10 per cent remaining or at risk of <10 per cent remaining, within the urban, industrial and rural residential footprints.

A commitment has also been made to increase protection of areas of remnant vegetation representative of vegetation complexes with <30 per cent remaining within urban industrial and rural residential areas through future statutory planning.

Within the infrastructure footprint, the intersect areas provide an early indication of the scale of potential impacts but will be subject to refinement of locations to avoid or minimise impacts, as described in Action Plan C. For BRM, the impacts presented represent the likely final outcomes (i.e. extent of clearing/impact), as detailed planning/master planning to avoid and minimise impacts has already taken place for BRM nodes.

Offsets will be delivered under the conservation program of the Strategic Conservation Plan and delivered through protection of an initial package of sites to expand the conservation estate, ongoing additions over the life of the conservation program and on-ground measures such as rehabilitation. Offsets delivered through this mechanism will not be direct (i.e. like for like). Instead, the program focuses on delivery of prioritised actions that are strategic in nature and focus on activities that primarily have multiple environmental benefits.

In its interim strategic advice, the EPA recognised that conservation planning should focus on retention of at least 30 per cent of all vegetation complexes in the unconstrained portions of the Perth and Peel regions. Implementation of Bush Forever, the Forest Management Plan 2014-2023, and protection of the Peel RSNAs will contribute to meeting this target (EPA 2015a).

Commitment: Avoid viable patches of vegetation complexes <10% remaining or at risk of <10% remaining, within the urban, industrial and rural residential footprints, through the planning process (Action Plans A and B).
Commitment: Protect areas of remnant vegetation representative of vegetation complexes with <30% remaining by:

- identifying opportunities for retention of remnant vegetation representative of vegetation complexes <30% within already zoned undeveloped urban, industrial and rural residential land;
- producing a spatial layer showing these areas of vegetation to be given due regard through the planning process; and
- prioritising for protection, as part of the conservation program, those areas that also have other environmental values.

5.7.6 Conservation significant ecological communities

Twenty-two TECs, three Priority 1 PECs and three Priority 2 PECs\(^5\) occur in the Advice Area. Of these, 14 TECs endorsed by the State Minister for Environment are also listed as Threatened under the EPBC Act; these are addressed in the Commonwealth IAR. The remaining eight TECs, along with the six PECs, have been assigned to one of four categories, which reflect the relative importance of the Advice Area to each community and the depth of impact assessment undertaken (Appendix B).

Potential impacts and approach to the analysis

Detailed impact analyses were undertaken for Category 1 and 2 ecological communities. Threatened or Priority ecological communities assigned to Category 3 or 4 have not been considered further as they have met a set of criteria indicating a low, or lack of reliance on potential habitat within the Advice Area. It is unlikely that these ecological communities will be significantly affected by actions of the proposed future development.

Five TECs and five PECs were assigned to Category 1 or Category 2 and have therefore been addressed in this document, as follows:

- *Banksia attenuata and/or Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain* (SCP20b)* Endangered TEC;
- *Banksia attenuata* woodlands over species rich dense shrublands* (SCP20a)* Endangered TEC;

\(^5\) A full description of how ecological communities come to be recognised as Threatened or Priority and the different rankings are presented in Appendix E. The State IAR addressed impacts to Priority 1 and 2 communities only. The OEPA advised that the IAR should address impacts to Priority 1 and 2 communities only, in line with the strategic nature of the assessment.
• ‘Eucalyptus calophylla - Eucalyptus marginata’ woodlands on sandy clay soils of the southern Swan Coastal Plain’ (SCP3b) Vulnerable TEC;
• ‘Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain’ (SCP15) Vulnerable TEC;
• ‘Melaleuca huegelii - Melaleuca acerosa’ shrublands on limestone ridges’ (Gibson et al. 1994 type 26a) (SCP26a) Endangered TEC;
• ‘Banksia ilicifolia’ woodlands, southern Swan Coastal Plain’ (SCP22) Priority 2 PEC;
• ‘Brackish microbial community number 1’ (Lake Walyungup) Priority 1 PEC;
• ‘Casuarina obesa association’ Priority 1 PEC;
• ‘Elongate fluviatile delta system’ Priority 1 PEC; and
• ‘Litter-dependent invertebrate community’ Priority 2 PEC.

The full list of TECs and Priority 1 and 2 PECs in the Advice Area and their assigned categories is provided in Appendix C. The known locations of the TECs and PECs assigned to Category 1 or Category 2 are provided in Figure 5-12.

The main potential impact to conservation significant ecological communities is clearing associated with the development of the footprints. The number and area of ecological communities intersected by the proposed future development has been calculated and reported in this Section. Only clearing impacts of >10 m² (0.001 ha) have been reported, to exclude errors due to spatial scale of mapping and provide focus on potentially significant impacts.

The analysis presented indicates potential impacts before consideration of further avoidance. An indication of the likely outcome of further avoidance has been provided for urban, industrial and rural residential footprints. For infrastructure, the intersect areas provide an early indication of the scale of potential impacts but will be subject to refinement of locations to avoid or minimise impacts, as described in Action Plan C. For BRM, the intersects represent the likely final outcomes (i.e. extent of clearing/impact) as detailed planning/master planning to avoid and minimise impacts has already taken place for BRM nodes.

For each of the five TECs addressed in this document, the impact analysis considered occurrences mapped by area within the Advice Area. Four of the TECs are also known from a number of recorded point locations in the Advice Area. The full spatial extent of these TECs has not yet been mapped; however, buffers were applied to each point location at an appropriate distance to match the nature of each community, as advised by Parks and Wildlife. These buffered point locations were included in the impact analysis. For the five PECs addressed in this document, the impact analysis considered occurrences mapped by area within the Advice Area for three PECs, and point locations (buffered as advised by Parks and Wildlife) for the remaining two PECs. For TECs and PECs mapped by area, the impact analysis was based on both the number of occurrences and the area intersected by the proposed development footprint; for buffered point locations, the impact analysis was based on the number of occurrences intersected.
Figure 5-12a (north-west): Threatened and Priority ecological communities in the Advice Area (Category 1 and 2)

Legend

**Advice Area**

**Threatened Ecological Communities**

* Banksia attenuata woodland over species rich dense shrublands (SCP20a, Endangered)

* Melaleuca huegelii - Melaleuca acerosa (currently M. systena) shrublands on limestone ridges (Gibson et al. 1994 type 26a) (SCP26a, Endangered)

**Priority Ecological Communities**

* Banksia ilicifolia woodlands, southern Swan Coastal Plain (SCP22, P2)
Figure 5-12b (north-east): Threatened and Priority ecological communities in the Advice Area (Category 1 and 2)

**Legend**

- **Advice Area**

**Threatened Ecological Communities**

- **Banksia attenuata** and/or **Eucalyptus marginata** woodlands of the eastern side of the Swan Coastal Plain (SCP20b, Endangered)

- **Banksia attenuata** woodland over species rich dense shrublands (SCP20a, Endangered)

- **Eucalyptus calophylla** - **Eucalyptus marginata** woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b, Vulnerable)

- Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (SCP15, Vulnerable)

- **Melaleuca huegelii** - **Melaleuca acerosa** (currently M. systena) shrublands on limestone ridges (Gibson et al. 1994 type 26a) (SCP26a, Endangered)

**Priority Ecological Communities**

- **Banksia ilicifolia** woodlands, southern Swan Coastal Plain (SCP22, P2)

- **Casuarina obesa** Association (P1)
Figure 5-12c (central): Threatened and Priority ecological communities in the Advice Area (Category 1 and 2)

Legend

**Advice Area**

**Threatened Ecological Communities**

- *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain (SCP20b, Endangered)
- *Banksia attenuata* woodland over species rich dense shrublands (SCP20a, Endangered)
- *Eucalyptus calophylla - Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b, Vulnerable)

**Priority Ecological Communities**

- *Banksia ilicifolia* woodlands, southern Swan Coastal Plain (SCP22, P2)
Figure 5-12d (south): Threatened and Priority ecological communities in the Advice Area (Category 1 and 2)

Legend

- **Advice Area**
- **Threatened Ecological Communities**
  - *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain (SCP20b, Endangered)
  - *Banksia attenuata* woodland over species rich dense shrublands (SCP20a, Endangered)
  - *Eucalyptus calophylla* - *Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b, Vulnerable)
  - Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (SCP15, Vulnerable)
  - *Melaleuca huegelii* - *Melaleuca acerosa* (currently *M. systena*) shrublands on limestone ridges (Gibson et al. 1994 type 26a) (SCP26a, Endangered)

- **Priority Ecological Communities**
  - *Banksia ilicifolia* woodlands, southern Swan Coastal Plain (SCP22, P2)
  - *Casuarina obesa* Association (P1)
  - Elongate Fluvial Delta System (P1)
  - Litter-dependant invertebrate community (P2)
  - Microbial community of a coastal saline lake (Lake Walyungup) (P1)
Impact analysis: Threatened ecological communities

The potential impacts to TECs in the Advice Area as a result of clearing associated with the proposed development are presented in Table 5-7 and Figure 5-17. Of the five TECs considered, the proposed development footprint intersects 59 of the 190 occurrences (31 per cent) and 92 ha of the 1,028 ha (9 per cent) of these TECs in the Advice Area. After consideration of DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints, the impact should be reduced from 59 to 47 occurrences and from 92 ha to 68 ha. The main impact to TECs is the proposed infrastructure footprint (Table 5-7), which will also be subject to further refinement of location to avoid or minimise impacts.

The ‘Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain’ TEC is not intersected by the proposed development footprint (Table 5-7). Potential impacts to the four remaining TECs are discussed below.

Banksia attenuata and/or Eucalyptus marginata woodlands of the eastern side of the Swan Coastal Plain

The ‘Banksia attenuata and/or Eucalyptus marginata woodlands of the eastern side of the Swan Coastal Plain’ TEC occurs on sandy soils and requires fresh superficial groundwater to sustain its key flora species. It is mainly found at the base of the Scarp between Byford and Yarloop on the Pinjarra Plain and Ridge Hill Shelf. It is predominantly made up of Eucalyptus marginata, Banksia attenuata and other Banksia species woodlands along with heaths. There is a diverse shrub layer that helps differentiate it from the two subgroups, ‘type 20a and 20c woodlands’, which are closely linked to this TEC (Gibson et al. 1994). The diverse shrub layer is made up of Hakea stenocarpa, Conostylis setosa, and Johnsonia aff. pubescens. This community is species-rich and has a low weed frequency (Gibson et al. 1994). The extent of this TEC in WA is 28 ha, of which 262 ha is in the Advice Area, across 37 occurrences.

Of the 37 occurrences and 262 ha in the Advice Area, 12 occurrences (32 per cent) and 18 ha (7 per cent) are intersected by the proposed development footprint (Table 5-7), as follows:

- 10 occurrences and 10 ha within the infrastructure footprint (Occurrences 162, 520, 521, 522, 523, 644, 731, 753, 771 and 5058);
- One occurrence and 2 ha within the urban footprint (Occurrence 4895);
- One occurrence and 5 ha within the industrial footprint (Occurrence 5445); and
- One occurrence and 0.04 ha within the rural residential footprint (Occurrence 644).

The impacts to this ecological community would be unchanged based on DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints (Table 5-7). The main potential impact to this TEC is the infrastructure footprint, primarily existing rail reserves. The infrastructure footprint will be subject to further refinement of location to avoid or minimise impacts, and this impact may be reduced as a result of this.

In order to provide context for potential cumulative impacts to this TEC, the relative levels of protection for this ecological community (see Section 5.7.2) are provided in Figure 5-13. A large proportion of this TEC occurs in secure conservation tenure or land sympathetic to conservation.
The ‘Banksia attenuata woodlands over species rich dense shrublands’ TEC was originally described by Gibson et al. (1994) as ‘community type 20a’ and occurs on yellow sand ridges. It is usually dominated by *Banksia attenuata* (occasionally with *Eucalyptus marginata*), with *Bossiaea eriocarpa*, *Conostephium pendulum*, *Hibbertia huegelii*, *H. hypericoides*, *Petrophile linearis*, *Scaevola repens*, *Stirlingia latifolia*, *Mesomelaena pseudostygia* and *Alexgeorgea nitens* common in the understorey. The introduced bulb *Gladiolus caryophyllaceus* is also common in the community. This TEC is the richest of any of the *Banksia* communities recorded, with an average species richness of 67.4 per site (Gibson et al. 1994).

Of the 56 occurrences and 441 ha in the Advice Area, 27 occurrences (48 per cent) and 45 ha (10 per cent) are intersected by the proposed development footprint (Table 5-7), as follows:

- 25 occurrences and 32 ha within the infrastructure footprint (Occurrences 3, 4, 7, 533, 650, 667, 718, 737, 739, 744, 745, 886, 1866, 1896, 1901, 1916, 2526, 4058, 4081, 4452, 4675, 5036, 5059, 5179 and 5538);
- Six occurrences and 9 ha within the urban footprint (Occurrences 450, 7, 1896, 1831, 4058 and 5036);
- One occurrence and 0.03 ha within the industrial footprint (Occurrence 739); and
- One occurrence and 4 ha within the rural residential footprint (Occurrence 450).

After consideration of DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints, the impact to this ecological community is likely to be reduced from 27 to 26 occurrences and from 45 ha to 34 ha, as a result of reduced impact in the urban and rural residential footprints (Table 5-7). The main potential impact to this TEC is the infrastructure footprint, primarily existing road reserves. The infrastructure footprint will be subject to further refinement of location to avoid or minimise impacts, and this impact may be reduced as a result of this.

In order to provide context for potential cumulative impacts to this TEC, the relative levels of protection for this ecological community (see Section 5.7.2) are provided in Figure 5-14. A large proportion of this
TEC within the Advice Area occurs within Bush Forever sites or crown reserves with conservation listed in the purpose of the reserve.

![Figure 5-14: Relative levels of protection for Banksia attenuata woodland over species rich dense shrublands occurrences. Numbers indicate total area in each level of protection.](image)

_Eucalyptus calophylla - Eucalyptus marginata_ woodlands on sandy clay soils of the southern Swan Coastal Plain

The ‘*Eucalyptus calophylla - Eucalyptus marginata*’ woodlands on sandy clay soils of the southern Swan Coastal Plain’ TEC was originally described by Gibson et al. (1994) as ‘community type 3b’. Most sites of this community type are dominated by both *Corymbia calophylla* (previously *E. calophylla*) and *E. marginata*. *Bossiaea eriocarpa* and *Conostylis juncea* differentiate this subgroup from similar communities. Many of the occurrences of this TEC are found on the alluvial soils and better-drained sites on the eastern side of the Swan Coastal Plain. The extent of this TEC in WA is 293 ha, of which 173 ha is in the Advice Area, across 37 occurrences.

Of the 37 occurrences and 172 ha in the Advice Area, seven occurrences (19 per cent) and 15 ha (9 per cent) are intersected by the proposed development footprint (Table 5-7), as follows:

- Seven occurrences and 13 ha within the infrastructure footprint (Occurrences 457, 501, 525, 4099, 5062, 5064 and 5065);
- Three occurrences within the urban footprint (Occurrences 501, 525 and 5065); and
- One occurrence and 1 ha within the rural residential footprint (Occurrence 457).

After consideration of DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints, the impact to this ecological community is likely to be reduced from seven to five occurrences and from 15 ha to 13 ha, as a result of reduced impact in the urban and rural residential footprints (Table 5-7). The main potential impact to this TEC is the infrastructure footprint, primarily existing rail reserves. The infrastructure footprint will be subject to further refinement of location to avoid or minimise impacts, and this impact may be reduced as a result of this.
In order to provide context for potential cumulative impacts to this TEC, the relative levels of protection for this ecological community (see Section 5.7.2) are provided in Figure 5-15. A large proportion of this TEC occurs in secure conservation tenure or land sympathetic to conservation.

![Figure 5-15: Relative levels of protection for *Eucalyptus calophylla - Eucalyptus marginata* woodlands occurrences. Numbers indicate total area in each level of protection.](image)

*Figure 5-15: Relative levels of protection for *Eucalyptus calophylla - Eucalyptus marginata* woodlands occurrences. Numbers indicate total area in each level of protection.*

**Melaleuca huegelli - Melaleuca acerosa** shrublands on limestone ridges

*Melaleuca huegelli – Melaleuca acerosa* shrublands are species-rich thickets, heaths or scrubs. They occur on skeletal soil on ridge slopes and ridge tops (Gibson et al. 1994). The ‘*Melaleuca huegelli – Melaleuca acerosa* shrublands on limestone ridges’ TEC is highly restricted, occurring around Yanchep north of Perth and south near Lake Clifton. The extent of this ecological community in WA is 208 ha, of which 128 ha is in the Advice Area, across 53 occurrences.

Of the 53 occurrences and 128 ha in the Advice Area, 13 occurrences (25 per cent) and 14 ha (11 per cent) are intersected by the proposed development footprint (Table 5-7), as follows:

- Five occurrence and 3 ha within the BRM footprint (Occurrences 1877, 1890, 1933, 4022 and 5114);
- Five occurrence and less than 1 ha within the infrastructure footprint (Occurrences 725, 729, 1890, 1898 and 1899); and
- Four occurrences and 10 ha within the industrial footprint (Occurrences 417, 1838, 1871 and 1893).

After consideration of DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints, the impact to this ecological community would be reduced from 13 to nine occurrences and from 14 ha to 3 ha, as a result of reduced impact in the industrial footprint (Table 5-7). The main potential impact to this TEC is the BRM footprint.

In order to provide context for potential cumulative impacts to this TEC, the relative levels of protection for this ecological community (see Section 5.7.2) are provided in Figure 5-16. A large proportion of this TEC occurs in secure conservation tenure.
Impact analysis: Priority ecological communities

The potential impacts to PECs in the Advice Area as a result of clearing associated with the proposed development are presented in Table 5-8 and Figure 5-17. Of the five PECs considered, the proposed development footprint intersects 7 of the 41 occurrences (17 per cent) affecting three PECs and 79 ha of the 738 ha (11 per cent) of the total area of these PECs in the Advice Area. DoP’s preliminary assessment of future avoidance within the urban, industrial and rural residential expansion areas identified one occurrence that would likely be retained through statutory planning. Impacts are from the infrastructure (4 occurrences), BRM (1 occurrence), and rural residential (1 occurrence) footprints (Table 5-8).

Two of the PECs considered are not intersected by the proposed development footprint: the ‘Brackish microbial community number 1’ (Lake Walyungup) Priority 1 PEC and the ‘Litter-dependent invertebrate community’ Priority 2 PEC (Table 5-8).

Potential impacts to the three remaining PECs are as follows:

- **Banksia ilicifolia** woodlands, southern Swan Coastal Plain: One occurrence is intersected by the proposed BRM footprint (Occurrence 3083) and three occurrences are intersected by the proposed infrastructure footprint (Occurrences 2979, 3085 and 5021) (Table 5-8). The infrastructure footprint will be subject to further refinement of location to avoid or minimise impacts, and impacts to this PEC may be reduced as a result of this.

- **Casuarina obesa** association: One occurrence is intersected by the proposed infrastructure footprint (Occurrence 4091) and one occurrence is intersected by the proposed rural residential footprint (Occurrence 4094). Based on DoP’s preliminary assessment of further avoidance, the occurrence within the rural residential footprint is likely to be avoided through future statutory planning (Table 5-8). The infrastructure footprint will be subject to further refinement of location to avoid or minimise impacts, and may avoid impacting this PEC.

- **Elongate fluviatile** delta system: The only occurrence of this PEC is intersected in part (15 per cent) by the proposed rural residential footprint (Occurrence 3417). After consideration of DoP’s
preliminary assessment of likely future avoidance within the rural residential footprints, the impact to this ecological community is unchanged (Table 5-8).
Table 5-7: Potential impacts to TECs in the Advice Area before and after consideration of further likely avoidance

<table>
<thead>
<tr>
<th>Community, code and conservation status</th>
<th>No. in Advice Area (area in hectares shown in parentheses)¹</th>
<th>No. of TECs intersected by the proposed development footprint (area in hectares shown in parentheses)¹</th>
<th>BRM²</th>
<th>Infrastructure</th>
<th>Urban</th>
<th>Industrial</th>
<th>Rural</th>
<th>Residential</th>
<th>All footprints combined</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Banksia attenuata and/or Eucalyptus marginata</strong> woodlands of the eastern side of the Swan Coastal Plain (SCP20b, Endangered)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>37 (262)</td>
<td>0</td>
<td></td>
<td>10 (10)</td>
<td>1 (2)</td>
<td>1 (5)</td>
<td>1 (&lt;0.1)</td>
<td>12 (18)</td>
<td></td>
</tr>
<tr>
<td>After known further avoidance</td>
<td></td>
<td></td>
<td>To be determined</td>
<td>1 (2)</td>
<td>1 (5)</td>
<td>1 (&lt;0.1)</td>
<td></td>
<td>&lt;12 (18)</td>
<td></td>
</tr>
<tr>
<td><strong>Banksia attenuata</strong> woodland over species rich dense shrublands (SCP20a, Endangered)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>56 (441)</td>
<td>0</td>
<td></td>
<td>25 (32)</td>
<td>6 (9)</td>
<td>1 (&lt;0.1)</td>
<td>1 (4)</td>
<td>27 (45)</td>
<td></td>
</tr>
<tr>
<td>After known further avoidance</td>
<td></td>
<td></td>
<td>To be determined</td>
<td>3 (2)</td>
<td>1 (&lt;0.1)</td>
<td>0</td>
<td></td>
<td>&lt;26 (34)</td>
<td></td>
</tr>
<tr>
<td><strong>Eucalyptus calophylla - Eucalyptus marginata</strong> woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b, Vulnerable)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>37 (173)</td>
<td>0</td>
<td></td>
<td>7 (13)</td>
<td>3 (0)</td>
<td>0</td>
<td>1 (1)</td>
<td>7 (15)</td>
<td></td>
</tr>
<tr>
<td>After known further avoidance</td>
<td></td>
<td></td>
<td>To be determined</td>
<td>2 (0)</td>
<td>0</td>
<td></td>
<td></td>
<td>&lt;7 (13)</td>
<td></td>
</tr>
<tr>
<td><strong>Melaleuca huegelli - Melaleuca acerosa</strong> shrublands on limestone ridges (Gibson et al. 1994 type 26a) (SCP26a, Endangered)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>53 (128)</td>
<td>5 (3)</td>
<td></td>
<td>5 (&lt;1)</td>
<td>0</td>
<td>4 (10)</td>
<td>0</td>
<td>13 (14)</td>
<td></td>
</tr>
<tr>
<td>After known further avoidance</td>
<td></td>
<td></td>
<td>To be determined</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td>9 (3)</td>
<td></td>
</tr>
</tbody>
</table>

¹ Values apply to both before and after consideration of further likely avoidance (i.e. no change) unless separate before and after values are provided. The number of occurrences shown in this table includes occurrences mapped by area and buffered point locations.

² Totals are not cumulative as impacts across footprints may relate to the same occurrence.
### Table 5-8: Potential impacts to PECs in the Advice Area before and after consideration of further likely avoidance

<table>
<thead>
<tr>
<th>Community, code and conservation status</th>
<th>No. in Advice Area (area in hectares shown in parentheses)(^1)</th>
<th>PECs intersected by the proposed development footprint (area in hectares shown in parentheses)(^1,2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BRM</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>Banksia ilicifolia woodlands, southern Swan Coastal Plain (SCP22, P2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>34</td>
<td>1</td>
</tr>
<tr>
<td>After known further avoidance</td>
<td>34</td>
<td>1</td>
</tr>
<tr>
<td>Casuarina obesa association (P1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>After known further avoidance</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Elongate fluviatile delta system (P1) before and after known further avoidance</td>
<td>1 (519)</td>
<td>0</td>
</tr>
</tbody>
</table>

\(^1\) The number of occurrences shown in this table includes occurrences mapped by area and buffered point locations. Areas of *B. ilicifolia* woodlands, southern Swan Coastal Plain and *C. obesa* association could not be reported as data are points only.

\(^2\) Values apply to both before and after consideration of further likely avoidance (i.e. no change) unless separate before and after values are provided.
Figure 5-17a (north-west): Potential impacts to Threatened and Priority ecological communities in the Advice Area

Legend

Advice Area
Intersected Threatened Ecological Communities

Threatened Ecological Communities

*Banksia attenuata* woodland over species rich dense shrublands (SCP20a, Endangered)

*Melaleuca huegelli - Melaleuca acerosa* (currently *M. systena*) shrublands on limestone ridges (Gibson et al. 1994 type 26a) (SCP26a, Endangered)

Priority Ecological Communities

*Banksia ilicifolia* woodlands, southern Swan Coastal Plain (SCP22, P2)
Figure 5-17b (north-east): Potential impacts to Threatened and Priority ecological communities in the Advice Area

Legend
- **Advice Area**
- Intersected Threatened Ecological Communities

**Threatened Ecological Communities**

- Banksia attenuata and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain (SCP20b, Endangered)
- Banksia attenuata woodland over species rich dense shrublands (SCP20a, Endangered)
- *Eucalyptus calophylla* - *Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b, Vulnerable)
- Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (SCP15, Vulnerable)
- Melaleuca huegelii - Melaleuca acerosa (currently *M. systena*) shrublands on limestone ridges (Gibson et al. 1994 type 26a) (SCP26a, Endangered)

**Priority Ecological Communities**

- Banksia ilicifolia woodlands, southern Swan Coastal Plain (SCP22, P2)
- *Casuarina obesa* Association (P1)
Figure 5-17c (central): Potential impacts to Threatened and Priority ecological communities in the Advice Area

Legend

- Advice Area
- Intersected Threatened Ecological Communities

Threatened Ecological Communities

- *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain (SCP20b, Endangered)
- *Banksia attenuata* woodland over species rich dense shrublands (SCP20a, Endangered)
- *Eucalyptus calophylla* - *Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b, Vulnerable)

Priority Ecological Communities

- *Banksia ilicifolia* woodlands, southern Swan Coastal Plain (SCP22, P2)
Figure 5-17d (south): Potential impacts to Threatened and Priority ecological communities in the Advice Area

**Legend**

- **Advice Area**
- **Intersected Threatened Ecological Communities**

**Threatened Ecological Communities**

- *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain (SCP20b, Endangered)
- *Banksia attenuata* woodland over species rich dense shrublands (SCP20a, Endangered)
- *Eucalyptus calophylla* - *Eucalyptus marginata* woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b, Vulnerable)
- Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (SCP15, Vulnerable)
- *Melaleuca huegelii* - *Melaleuca acerosa* (currently *M. systena*) shrublands on limestone ridges (Gibson et al. 1994 type 26a) (SCP26a, Endangered)

**Priority Ecological Communities**

- *Banksia ilicifolia* woodlands, southern Swan Coastal Plain (SCP22, P2)
- *Casuarina obesa* Association (P1)
- Elongate Fluvial Delta System (P1)
- Litter-dependant invertebrate community (P2)
- Microbial community of a coastal saline lake (Lake Walyungup) (P1)
**Management and mitigation**

Conservation significant ecological communities will be benefited by commitments presented in preceding sections of this document, in particular through commitments around protection of RSNAs and wetlands.

Action Plan F details the commitments for TECs that are also listed under the EPBC Act. Apart from these, specific commitments are provided in Action Plan G for each of the TECs and PECs that are impacted by the footprints. These commitments relate to further avoidance, minimisation of impacts, and management of occurrences of these communities, depending on the footprints they intersect.

Offsets will be delivered under the conservation program of the Strategic Conservation Plan and delivered through protection of an initial package of sites to expand the conservation estate, ongoing additions over the life of the conservation program and on-ground measures such as rehabilitation. Offsets delivered through this mechanism will not be direct (i.e. like for like). Instead, the program focuses on delivery of prioritised actions that are strategic in nature and focus on activities that primarily have multiple environmental benefits.

### Commitment: Maintain the long-term viability of the *Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain (SCP20b, Endangered) TEC within the Advice Area by:

- protecting and managing for conservation the following occurrences where they occur in Bush Forever sites:
  - 522, 521, 523 and 520 in Bush Forever Site 350
  - 753 in Bush Forever Site 365
  - 771 in Bush Forever Site 360
  - 644 in Bush Forever Site 61
  - 162 in Bush Forever Site 352;
- retaining (with consideration of appropriate vegetation buffers) occurrences 5445 and part of occurrence 4895 (as agreed with EPA) where they may be impacted by the urban or industrial footprints; and
- minimising impacts to the following occurrences where they may be impacted by the infrastructure footprint: 162, 520, 521, 522, 523, 731, 753, 771, and 5058.

Maintain the long-term viability of the *Banksia attenuata* woodland over species rich dense shrublands (SCP 20a, Endangered) TEC within the Advice Area by:

- protecting and managing for conservation the following occurrences where they occur in Bush Forever sites:
  - 1831 in Bush Forever Site 45
  - 450 in Bush Forever Site 51
  - 650 in Bush Forever Site 53
  - 7 in Bush Forever Site 122
Commitment: Maintain the long-term viability of the Melaleuca huegelii - Melaleuca acerosa (currently M. systena) shrublands on limestone ridges (Gibson et al. 1994 type 26a) (SCP26a, Endangered) TEC within the Advice Area by:

- protecting and managing for conservation the following occurrences where they occur in Bush Forever sites:
  - 417 in Bush Forever Site 293
  - 729, 725 and 1890 in Bush Forever Site 383;
- retaining (with consideration of appropriate vegetation buffers) occurrences 1838, 1871 and 1893 where they may be impacted by the urban or industrial land footprints;
- minimising impacts to the following occurrences where they may be impacted by the infrastructure footprint: 725, 729, 1890, 1898 and 1899; and
- allowing the loss of Occ 4022 as detailed in Action Plan D on the provision of suitable offsets.

Commitment: Maintain the long-term viability of the Eucalyptus calophylla - Eucalyptus marginata woodlands on sandy clay soils of the southern Swan Coastal Plain (SCP3b, Vulnerable) TEC in the Advice Area by:

- protecting and managing for conservation the following occurrences where they occur in Bush Forever sites:
  - 457 in Bush Forever Site 71
  - 525, 5062 and 5064 in Bush Forever Site 350
  - 501 in Bush Forever Site 449; and
- minimising impacts to the following occurrences where they may be impacted by the infrastructure footprint 457, 501, 525, 4099, 5062 and 5065.
Commitment: Minimise impacts to the Elongate Fluviatile Delta System - Peel-Harvey inlet (P1) ecological community intersected by existing undeveloped Rural residential land use.

Commitment: Minimise impacts to the following occurrences of the Banksia ilicifolia woodlands (SCP22, P2) PEC where they may be impacted by the infrastructure footprint: 2979, 3085 and 5021.

Commitment: Protect important occurrences of the Casuarina obesa association (P2) PEC through the following actions:

- require a survey to be undertaken to verify the location of occurrence 4094 within the rural residential footprint and seek to retain through subdivision design; and
- minimise impacts to occurrence 4091 where it may be impacted by the infrastructure footprint.

5.7.7 Conservation significant flora

Fifty-five Threatened flora\(^6\) species listed under the WC Act and 74 Priority 1 and Priority 2 flora species\(^7\) occur in the Advice Area. Of these, 47 Threatened flora species and one Priority flora species are listed under the EPBC Act and are therefore addressed in the Commonwealth IAR. The remaining eight Threatened flora species and 73 Priority flora species were evaluated according to their level of reliance on the Advice Area and assigned to one of four categories. The depth of impact assessment undertaken was based on this categorisation (Appendix B).

**Potential impacts and approach to the analysis**

Detailed impact analysis was undertaken for Category 1 and 2 flora species (high and moderate reliance on Advice Area). Threatened or Priority flora species assigned to Category 3 or 4 have not been considered further as they have met a set of criteria indicating a low, or lack of reliance on potential habitat within the Advice Area. It is unlikely that these flora species will be significantly affected by actions of the proposed future development. The full list of Threatened and Priority flora species occurring in the Advice Area and their assigned categories is provided in Appendix B. The known locations of the Threatened and Priority flora species assigned to Categories 1 and 2 are provided in Figure 5-18.

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\(^6\) A full description of how flora species come to be recognised as Threatened and the different rankings are presented in Appendix E.

\(^7\) The State IAR addressed impacts to Priority 1 and 2 flora species only. The OEPA advised that the IAR should address impacts to Priority 1 and 2 species only, in line with the strategic nature of assessment.
Seven Threatened flora species and 53 Priority flora species were assigned to Category 1 or Category 2 and have therefore been addressed in this document, as follows:

- *Austrostipa bronwenae* (Critically Endangered);
- *Austrostipa jacobsoniana* (Critically Endangered);
- *Diplolaena andrewsii* (Vulnerable);
- *Eremophila glabra* subsp. *chlorella* (Critically Endangered);
- *Marianthus paralius* (Critically Endangered);
- *Synaphea sp.* Pinjarra Plain (A.S. George 17182) (Critically Endangered);
- *Synaphea sp.* Serpentine (G.R. Brand 103) (Critically Endangered); and
- 27 Priority 1 and 26 Priority 2 flora species.

The main potential impact to conservation significant flora is clearing associated with the development of the footprints. The number of flora records and/or area or known and supporting habitat intersected by the proposed future development has been calculated and reported in this Section. Only clearing impacts of >10 m² (0.001 ha) have been reported, to exclude errors due to spatial scale of mapping and provide focus on potentially significant impacts.

The analysis presented indicates potential impacts before consideration of further avoidance. An indication of the likely outcome of further avoidance has been provided for urban, industrial and rural residential footprints based on preliminary assessment by DoP. For infrastructure, the intersect areas provide an early indication of the scale of potential impacts but will be subject to refinement of locations to avoid or minimise impacts, as described in Action Plan C. For BRM, the intersects represent the likely final outcomes (i.e. extent of clearing/impact) as detailed planning/master planning to avoid and minimise impacts has already taken place for BRM nodes.

The impact analysis for Threatened flora species was based on populations defined by Parks and Wildlife and areas of known and supporting habitat mapped by Parks and Wildlife. To define populations, Parks and Wildlife carried out a review of all populations and sub-populations to identify those where the current attribution of populations should be updated to better reflect populations ‘as geographically or otherwise distinct groups in the population between which there is little demographic or genetic exchange’. Existing populations of Threatened flora species were grouped based on geographic location for the purpose of this assessment. Any reference to ‘populations’ hereafter refers to these grouped populations.

The exceptions to this were *Austrostipa bronwenae* and *A. jacobsoniana*, both of which are now listed as Threatened flora under the WC Act, but until recently were listed as Priority 1 species. Due to an only recent re-listing as Threatened, a review of all populations and sub-populations of these two species had not been undertaken. The impact analysis for these two species was instead based on numbers of records. The impact analysis for Priority flora was also based on numbers of records; each record represents one or more individuals of a species. That is, a record may represent an individual, or may represent as group, sub-population or population. The impact analysis for *A. bronwenae*, *A. jacobsoniana* and Priority flora species also considered the number of records located within 200 m of a footprint as a surrogate for the lack of mapped known and supporting habitat. This mapping provides for uncertainty that may result from variability in accuracy of data and how population numbers have been allocated to the point data.
Figure 5-18: Threatened and Priority flora in the Advice Area (Category 1 and 2)

Legend

Advice Area

Threatened Flora

- *Austrostipa bronweneae* (Critically Endangered)
- *Austrostipa jacobsiana* (Critically Endangered)
- *Diplolaena andrewsii* (Vulnerable)
- *Eremophila glabra* subsp. *chiorella* (Critically Endangered)
- *Marianthus paraliius* (Critically Endangered)
- *Synaphea* sp. Pinjarra Plain (A.S. George 17182) (Critically Endangered)
- *Synaphea* sp. Serpentine (G.R. Brand 103) (Critically Endangered)

Priority Flora

- Priority Flora (P1)
- Priority Flora (P2)
Impact analysis: Threatened flora

The potential impacts to Threatened flora in the Advice Area as a result of clearing associated with the proposed development are presented in Table 5-9. This table provides the number of known populations or records of Threatened flora taxa in the Advice Area intersected by the proposed future development, along with either the area of the taxon’s known and supporting habitat, or number of additional records within 200 m of a footprint.

Of the seven Threatened flora species considered, the proposed development footprint intersects 10 of the 40 occurrences (25 per cent) and 7 ha of the 172 ha of known and supporting habitat (4 per cent) of four of these species in the Advice Area. After consideration of DoP’s preliminary assessment of likely future avoidance within the urban, industrial and rural residential expansion footprints, this is reduced from 10 to nine occurrences; however, the area of known and supporting habitat intersected is unchanged (7 ha). The main impact to these Threatened flora species arises from the proposed infrastructure footprint (Table 5-9).

Potential impacts to the four affected species are discussed below. The three Threatened species not intersected by the proposed development footprint and therefore not further considered are Austrostipa bronwenae, Diplolaena andrewsii and Marianthus paralius (Table 5-9).

Austrostipa jacobsiana

*Austrostipa jacobsiana* is a perennial clumping grass occurring on calcareous soils on the Swan Coastal Plain and generally in non-saline habitats (Williams 2011; FloraBase 2015). It is known from two records in the Advice Area (population counts unknown): one near Armadale and one in the very south of the Advice Area close to Bunbury (Figure 5-19). One of the two records of *A. jacobsiana* in the Advice Area is intersected by the urban footprint; the other record is located within 200 m of both the urban and infrastructure footprints, within Bush Forever Site No. 413 (protection level 2) (Table 5-9).

Eremophila glabra subsp. chlorella

*Eremophila glabra* subsp. *chlorella* is a prostrate and spreading or sprawling shrub (FloraBase 2015) that grows in winter wet depressions on sandy clays or sand, in low open heath, open woodland areas and around freshwater lakes (Brown and Buirchell 2011). The taxon is known from 5,584 mature plants across 10 populations, occurring at Cannington, Mogumber, Eneabba (approximately 250 km north of Perth) and Kenwick. Three populations occur in the Advice Area: at Cannington and Brixton Street Wetlands within winter wet palusplain wetlands (Figure 5-20). The taxon’s habitat therefore relies on the local catchment for the surface water and possibly groundwaters that sustain the palusplain wetlands; 18 ha of known and supporting habitat has been mapped in the Advice Area for *E. glabra* subsp. *chlorella*.

Of the three populations and 18 ha of known and supporting habitat in the Advice Area, two populations (67 per cent; PP1 and PP7) and 4 ha of known and supporting habitat (22 per cent) are intersected by the proposed development footprint.

PP1 contains approximately 50 individuals and is located in an area zoned as ‘Central City Area’ under a region scheme. It is intersected by a proposed electricity substation as part of the proposed infrastructure footprint. This population occurs within an occurrence of the ‘Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain’ TEC, within the boundary of a CCW (Carousel Swamp) and within a patch of the Guildford vegetation complex, which has less than 10 per cent of its pre-European extent in the Advice Area remaining (Table 5-5). The infrastructure footprint will be
subject to further refinement of location to avoid or minimise impacts, and this impact may be reduced as a result of this.

PP7 contains four individuals and is located in an area zoned as ‘Rural’ under a region scheme and within an occurrence of the ‘Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain’ TEC. It is located near a portion of Bush Forever Site No. 387, which is classified as ‘Parks and Recreation’ under a region scheme. This population is intersected by the proposed industrial footprint; however, DoP’s preliminary assessment suggest the area containing and surrounding this population has potential to be retained as part of future likely avoidance through statutory planning.

The final population (PP6) does not intersect with any of the footprints. This population contains four individuals and is located within a portion of Bush Forever Site No. 387 classified as ‘Parks and Recreation’ under a region scheme, within the boundary of a CCW (Brixton Street Wetlands) and within a patch of the Guildford vegetation complex.

*Synaphea* sp. Pinjarra Plain

*Synaphea* sp. Pinjarra Plain is an erect clumped shrub that grows on grey sandy loam, clay loams and laterites and is often found in seasonally wet areas (FloraBase 2015). It is known from 44 populations (population size unknown), 16 of which occur in the Advice Area. These populations are located in the southern portion of the Advice Area, on the edge of the Swan Coastal Plain and Jarrah Forest bioregions from just north of Jarrahdale to just north of Pinjarra (Figure 5-21). The extent of this taxon’s known and supporting habitat in the Advice Area is approximately 34 ha.

Of the 16 populations and 34 ha of known and supporting habitat in the Advice Area, four populations (25 per cent; PP4, PP10, PP11 and PP12) and 5 ha of known and supporting habitat (15 per cent) are intersected by the proposed development footprint. The main potential impact to this taxon is the proposed infrastructure footprint, including existing rail reserves and proposed road reserves and water pipelines. The infrastructure footprint will be subject to further refinement of location to avoid or minimise impacts, and this impact may be reduced as a result of this.

Potentially impacted populations are:

- **PP4**: This population is intersected by a proposed water pipeline as part of the proposed infrastructure footprint.
- **PP10**: This population is located within an occurrence of the ‘Herb Rich shrublands in clay pans’ TEC and Bush Forever Site No. 360. It is intersected by a proposed water pipeline and road reserve as part of the proposed infrastructure footprint.
- **PP11 and PP12**: These populations are located in Bush Forever Site No. 350 and are intersected by existing rail reserves as part of the proposed infrastructure footprint.

Of the remaining 12 populations in the Advice Area, three of these (PP3, PP8 and PP9) are within land that is considered sympathetic to conservation (protection level 1-4, see Section 5.7.2). Six populations (PP2, PP5, PP6, PP13, PP14, PP16) are in areas that sit outside land that is sympathetic to conservation, and that are unlikely to be developed (protection level 5). One population (PP15) is within an existing zoned urban or industrial area, representing a high risk of loss (protection level 6-7). The remaining two populations are across land afforded more range of protection levels.
Synaphea sp. Serpentine

Synaphea sp. Serpentine is a perennial shrub that generally grows on sandy brown and clay loam soils and occurs in areas that are seasonally damp and around wetlands (FloraBase 2015). It is known from 48 populations (population size unknown), 12 of which occur in the Advice Area. These populations occur mainly around Serpentine; the taxon also occurs south of Armadale, south of Waroona and between Bunbury and Busselton (approximately 180 km south of Perth) (Figure 5-22). The extent of this taxon’s known and supporting habitat in the Advice Area is approximately 30 ha.

Of the 12 populations and 30 ha of known and supporting habitat in the Advice Area, three populations (25 per cent; PP4, PP5 and PP6) and 3 ha of known and supporting habitat (10 per cent) are intersected by the proposed development footprint. The infrastructure footprint will be subject to further refinement of location to avoid or minimise impacts, and this impact may be reduced as a result of this.

Potentially impacted populations are:

- PP4: population is located in Bush Forever Site No. 350 and an occurrence of the ‘Banksia attenuata and/or Eucalyptus marginata woodlands of the eastern side of the Swan Coastal Plain’ TEC. It is intersected by existing rail reserves as part of the proposed infrastructure footprint.
- PP5: This population is located in Bush Forever Site No. 360 and is intersected by existing road reserves as part of the proposed infrastructure footprint.
- PP6: This population is located in Bush Forever Site No. 360 and adjacent to an occurrence of the ‘Herb rich shrublands in clay pans’ TEC. It is intersected by proposed road reserves as part of the proposed infrastructure footprint.

The existing level of protection (Section 5.7.2) afforded to the 10 remaining populations within the Advice Area is Level 1-4 (land that is considered sympathetic to conservation) for two populations (PP3 and PP13), Level 5 (outside land that is sympathetic to conservation, and that are unlikely to be developed) for five of the populations (PP7, PP8, PP9, PP10, PP12) and mixed levels of protection for two populations (PP1 and PP2).
### Table 5-9: Potential impacts to Threatened flora in the Advice Area before and after consideration of further likely avoidance

<table>
<thead>
<tr>
<th>Species and conservation status (WC Act)</th>
<th>No. in Advice Area (area in hectares of known and supporting habitat shown in parentheses)</th>
<th>Threatened flora intersected by the proposed development footprint (area in hectares of known and supporting habitat shown in parentheses) [+ additional records within 200 m shown in brackets]</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Austrostipa jacobsiana</strong> (Critically Endangered)</td>
<td>2</td>
<td>BRM: Nil, 0 [+2]&lt;br&gt;Infrastructure: Nil, 1 [+1]&lt;br&gt;Urban: Nil, 1 (&lt;0.1)&lt;br&gt;Industrial: Nil, 1 (&lt;0.1)&lt;br&gt;Rural Residential: Nil, 1 (&lt;0.1)&lt;br&gt;All footprints combined: 1 [+1]&lt;br&gt;</td>
</tr>
<tr>
<td><strong>Eremophila glabra subsp. chlorella</strong> (Critically Endangered)</td>
<td>3 (18)</td>
<td>BRM: Nil, 1 (4)&lt;br&gt;Infrastructure: Nil, 1 (4)&lt;br&gt;Urban: Nil, 1 (4)&lt;br&gt;Industrial: Nil, 1 (4)&lt;br&gt;Rural Residential: Nil, 1 (4)&lt;br&gt;All footprints combined: 2 (4)&lt;br&gt;</td>
</tr>
<tr>
<td><strong>Synaphea sp. Pinjarra Plain</strong> (A.S. George 17182) (Critically Endangered)</td>
<td>16 (34)</td>
<td>BRM: Nil, 4 (5)&lt;br&gt;Infrastructure: Nil, 4 (5)&lt;br&gt;Urban: Nil, 4 (5)&lt;br&gt;Industrial: Nil, 4 (5)&lt;br&gt;Rural Residential: Nil, 4 (5)&lt;br&gt;All footprints combined: 4 (5)&lt;br&gt;</td>
</tr>
<tr>
<td><strong>Synaphea sp. Serpentine</strong> (G.R. Brand 103) (Critically Endangered)</td>
<td>12 (30)</td>
<td>BRM: Nil, 3 (2)&lt;br&gt;Infrastructure: Nil, 3 (2)&lt;br&gt;Urban: Nil, 3 (2)&lt;br&gt;Industrial: Nil, 3 (2)&lt;br&gt;Rural Residential: Nil, 3 (2)&lt;br&gt;All footprints combined: 3 (2)&lt;br&gt;</td>
</tr>
</tbody>
</table>

1 Values for *Austrostipa bronwenae* and *Austrostipa jacobsiana* are records. Values for *Diplolaena andrewsii*, *Eremophila glabra subsp. chlorella*, *Marianthus paralius*, *Synaphea sp. Pinjarra Plain* (A.S. George 17182) and *Synaphea sp. Serpentine* (G.R. Brand 103) are populations.

2 Values apply to both before and after consideration of further likely avoidance (i.e. no change) unless separate before and after values are provided.
Figure 5-19: Potential impacts to known records of *Austrostipa jacobsiana* within the Advice Area

Legend

- **Austrostipa jacobsiana**
  - records
  - records - Potential impacts
- Development footprint

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: DPawW (May 2015)
Prepared by: SM Date: 27/11/2015
Figure 5-20: Potential impacts to known populations of *Eremophila glabra* subsp. *chlorella* within the Advice Area

**Legend**

- Blue dot: *Eremophila glabra* subsp. *chlorella* populations
- Red dot: *Eremophila glabra* subsp. *chlorella* populations - Potential impacts
- Development footprint

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: DPaW (May 2015)
Prepared by: SM Date: 18/11/2015
Figure 5-21: Potential impacts to known populations of *Synaphea* sp. Pinjarra Plain within the Advice Area

Legend

- **Advice Area**
- *Synaphea* sp. Pinjarra Plain (A.S. George 17182) populations
- *Synaphea* sp. Pinjarra Plain (A.S. George 17182) populations - Potential impacts
- Development footprint

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: DPaW (May 2015)
Prepared by: SM Date: 18/11/2015
Figure 5-22: Potential impacts to known populations of *Synaphea* sp. Serpentine within the Advice Area

Legend

- **Advice Area**
- *Synaphea* sp. Serpentine (G.R. Brand 103) populations
  - *Synaphea* sp. Serpentine (G.R. Brand 103) populations - Potential impacts
- **Development footprint**

Datum/Projection: GDA 1994 MGA Zone 50
Data Source: DPaw (May 2015)
Prepared by: SM Date: 18/11/2015
Impact analysis: Priority flora

The potential impacts to Priority flora in the Advice Area as a result of clearing associated with the proposed development are presented in Table 5-10 and Figure 5-23. Of the 53 Priority flora species considered, the proposed development footprint intersects 33 of the 497 records (7 per cent), potentially affecting 12 of these species in the Advice Area. After consideration of future likely avoidance through statutory planning within the urban, industrial and rural residential footprints, the potential impact is reduced from 33 to 25 records. The primary intersects to these Priority flora species occur from the proposed urban footprint (14 records, predominantly within existing zoned urban consolidation areas, with an additional 22 records within 200 m of the urban footprint) and proposed infrastructure footprint (eight records, predominantly within proposed power transmission line corridors, with an additional 101 records within 200 m of the infrastructure footprint) (Table 5-10). There are existing and potential means to ensure further retention and protection of areas of vegetation supporting Priority flora in existing zoned urban consolidation areas and not all of this area should be assumed to be cleared. DoP has not undertaken a preliminary assessment of future likely avoidance to date in these areas as it has done for expansion areas.

Forty-one of the species considered are not intersected by the proposed development footprint, although many have records within 200 m of the proposed development footprint (Table 5-10). Potential impacts to the 12 potentially directly affected species are as follows:

- **Acacia benthamii** (Priority 2): The proposed development footprint intersects four of the 38 records in the Advice Area (11 per cent). The main impact to this species is the proposed urban footprint. After consideration of DoP’s preliminary assessment of likely future avoidance within the urban expansion footprints, the impact is reduced from four to two records, one each in the urban and rural residential footprint.

- **Amanita carneiphyla** (Priority 2): The proposed development footprint intersects eight of the 17 records in the Advice Area (47 per cent). This potential impact is due to the urban footprint and has not been identified in DoP’s preliminary assessment of likely future avoidance.

- **Amanita griseibrunnea** (Priority 2): The proposed development footprint intersects one of the three records in the Advice Area (33 per cent). This potential impact is due to the urban footprint and according to DoP’s preliminary assessment of future avoidance is likely to remain unchanged.

- **Calectasia sp. Pinjar** (C. Tauss 557) (Priority 1): The proposed development footprint intersects five of the 12 records in the Advice Area (42 per cent). This potential impact is due to the industrial footprint. All five records have been identified in likely future avoidance areas in DoP’s preliminary assessment.

- **Craspedia argillicola** (Priority 2): The proposed development footprint intersects two of the four records in the Advice Area (50 per cent). This potential impact is due to the infrastructure footprint and may be reduced through refinement of the location of infrastructure to avoid or minimise impacts, as described in Action Plan C.

- **Dampiera triloba** (Priority 1): The proposed development footprint intersects four of the seven records in the Advice Area (57 per cent). Impacts to this species are from the proposed infrastructure footprint (3 records) and urban footprint (1 record). This potential impact is due to the infrastructure footprint and may be reduced through refinement of the location of infrastructure to avoid or minimise impacts, as described in Action Plan C.

- **Fabronia hampeana** (Priority 2): The proposed development footprint intersects one of the 10 records in the Advice Area (10 per cent). This potential impact is due to the infrastructure footprint.
and may by reduced through refinement of the location of infrastructure to avoid or minimise impacts, as described in Action Plan C.

- *Johnsonia pubescens* subsp. *cygnorum* (Priority 2): The proposed development footprint intersects one of the 16 records in the Advice Area (6 per cent). This potential impact is due to the urban footprint, and has been identified in DoP’s preliminary assessment for likely avoidance.

- *Melaleuca* sp. Wanneroo (G.J. Keighery 16705) (Priority 1): The proposed development footprint intersects 5 of the 6 records of this species in the Advice Area (83 per cent). Four of these are intersected by the BRM footprint and are likely to be lost. The fifth is within the industrial footprint and is not in an area identified by DoP for likely avoidance.

- *Millotia tenuifolia* var. *laevis* (Priority 2): The proposed development footprint intersects two of the six records in the Advice Area (33 per cent). This potential impact is due to the BRM footprint and is likely to remain unchanged following future avoidance.

- *Thelymitra magnifica* (Priority 1): The proposed development footprint intersects one of the 25 records in the Advice Area (4 per cent). This potential impact is due to the infrastructure footprint and may by reduced through refinement of the location of infrastructure to avoid or minimise impacts, as described in Action Plan C.

- *Tripterococcus paniculatus* (Priority 1): The proposed development footprint intersects three of the 28 records in the Advice Area (11 per cent). Impacts to this species are from the proposed urban (2 records) and infrastructure (1 record) footprints. The impact to 1 record from the infrastructure footprint may by reduced through refinement of the location of infrastructure to avoid or minimise impacts, as described in Action Plan C.
Table 5-10: Potential impacts to Priority flora in the Advice Area before and after consideration of further likely avoidance

<table>
<thead>
<tr>
<th>Species and Priority level</th>
<th>No. records in Advice Area</th>
<th>Priority flora records intersected by the proposed development footprint [+ additional records within 200 m shown in brackets]¹²³</th>
<th>BRM</th>
<th>Infrastructure</th>
<th>Urban</th>
<th>Industrial</th>
<th>Rural</th>
<th>Residential</th>
<th>All footprints combined⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before further avoidance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indicative after further avoidance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amanita griseibrunnea (P2)</td>
<td>3</td>
<td></td>
<td>0 [+1]</td>
<td>1 [+1]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1 [+1]</td>
<td></td>
</tr>
<tr>
<td>Andersonia sp. Saxatilis (F. &amp; J. Hort 3324) (P1)</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anthotium sp. Darling Range (F. Hort &amp; B. Hort 2431) (P1)</td>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baeckea sp. Limestone (N. Gibson &amp; M.N. Lyons 1425) (P1)</td>
<td>9</td>
<td></td>
<td>0 [+2]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0 [+2]</td>
<td></td>
</tr>
<tr>
<td>Bossiaea modesta (P2)</td>
<td>111 0 [+1]</td>
<td></td>
<td>0 [+1]</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0 [+1]</td>
<td></td>
</tr>
<tr>
<td>Before further avoidance</td>
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<tr>
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<tr>
<td>Species and Priority level</td>
<td>No. records in Advice Area</td>
<td>Priority flora records intersected by the proposed development footprint [+ additional records within 200 m shown in brackets]¹²</td>
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<td>BRM</td>
<td>Infrastructure³</td>
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<td>Industrial</td>
<td>Rural</td>
<td>Residential</td>
<td>All footprints combined⁴</td>
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<td>Gastrolobium nudum (P2)</td>
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<td>Gastrolobium sp. Harvey (G.J. Keighery 16821) (P2)</td>
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<td>0 [+1]</td>
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<td>Hydrocotyle striata (P1)</td>
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<td>Isopogon sp. Canning Reservoir (M.D. Tindale 121 &amp; B.R. Maslin) (P1)</td>
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<td>Species and Priority level</td>
<td>No. records in Advice Area</td>
<td>Priority flora records intersected by the proposed development footprint [(\pm) additional records within 200 m shown in brackets](^{1,2})</td>
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<td>BRM</td>
<td>Infrastructure(^3)</td>
<td>Urban</td>
<td>Industrial</td>
<td>Rural</td>
<td>Residential</td>
<td>All footprints combined(^4)</td>
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<td><strong>Johnsonia pubescens subsp. cygnorum (P2)</strong></td>
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<td><strong>Lecania sylvestris (P2)</strong></td>
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<td><strong>Lecania turicensis var. turicensis (P2)</strong></td>
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<td><strong>Lepidium pseudohyssopifolium (P1)</strong></td>
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<td><strong>Leucopogon maritimus Hislop (P1)</strong></td>
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<td><strong>Melaleuca sp. Wanneroo (G.J. Keighery 16705) (P1)</strong></td>
<td>6</td>
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<td><strong>Paracaleana gracilicordata (P1)</strong></td>
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<td><strong>Paracaleana granitica (P1)</strong></td>
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<tr>
<td><strong>Phyllangium palustre (P2)</strong></td>
<td>6</td>
<td>-</td>
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<td><strong>Ptilotus sericostachyus subsp. roseus (P1)</strong></td>
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<tr>
<td><strong>Rinodina bischoffii (P2)</strong></td>
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<tr>
<td><strong>Schoenus sp. Bullsbrook (J.J. Alford 915) (P2)</strong></td>
<td>1</td>
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<td><strong>Scholtzia sp. Bickley (W.H. Loaring s.n. PERTH 06165184) (P1)</strong></td>
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<td>Species and Priority level</td>
<td>No. records in Advice Area</td>
<td>Priority flora records intersected by the proposed development footprint [+ additional records within 200 m shown in brackets]¹²</td>
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<td>BRM</td>
<td>Infrastructure³</td>
<td>Urban</td>
<td>Industrial</td>
<td>Rural Residential</td>
<td>All footprints combined⁴</td>
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<td>Senecio gilbertii (P1)</td>
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<td>0 [+2] 0 [+2]</td>
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<td>Stachystemon sp. Keysbrook (R. Archer 17/11/99) (P1)</td>
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<tr>
<td>Stenanthemum sublineare (P2)</td>
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<td>-</td>
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<td>0 [+1]</td>
<td>0 [+2]</td>
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<tr>
<td>Stylidium aceratum (P2)</td>
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<td>Stylidium sp. Boulder Rock (A.H. Burbidge 2536) (P2)</td>
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<td>0 [+4]</td>
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<td>Tetratheca phoenix (P2)</td>
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<tr>
<td>Xanthoparmelia darlingensis (P1)</td>
<td>1</td>
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</tbody>
</table>

¹ Values apply to both before and after consideration of further likely avoidance (i.e. no change) unless separate before and after values are provided.

² A dash (-) indicates that there are no records intersected by or within 200 m of the proposed development footprints.

³ Refinement of the infrastructure footprint could lead to a reduction in these impacts.

⁴ Totals are not cumulative as impacts across footprints may relate to the same occurrence.
Figure 5-23: Potential impacts to known records of Priority 1 and 2 flora within the Advice Area (category 1 and 2)

Legend
- Advice Area
- Priority flora records
- Priority flora records - Development footprint
- Potential impacts

Prepared by: SM  Date: 18/11/2015
Data Source: DPaW (May 2015)
Datum/Projection: GDA 1994 MGA Zone 50
Management and mitigation

Conservation significant flora species will benefit from commitments for protection of RSNAs, wetlands and conservation significant ecological communities presented in preceding sections of this document.

Action Plan F details the commitments for threatened flora that are also listed under the EPBC Act. Apart from these, specific commitments are provided in Action Plan G for each of threatened flora that are impacted by the footprints. These commitments relate to further avoidance, minimisation of impacts, and management of occurrences of these communities, depending of the footprints they intersect.

In addition, a commitment has been made to develop and implement a survey and research program for priority flora species. This program will be designed to gain a better understanding of the potential importance of the Perth-Peel area to priority flora species in order to inform management and conservation planning into the future.

Offsets will be delivered under the conservation program of the Strategic Conservation Plan and delivered through protection of an initial package of sites to expand the conservation estate, ongoing additions over the life of the conservation program and on-ground measures such as rehabilitation. Offsets delivered through this mechanism will not necessarily like for like for priority flora species. Instead, the program focuses on delivery of prioritised actions that are strategic in nature and focus on activities that primarily have multiple environmental benefits.

<table>
<thead>
<tr>
<th>Commitment: Maintain the long-term viability of <em>Austrostipa jacobsiana</em> (Critically endangered) within the Advice Area by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• retaining (with consideration of appropriate vegetation buffers) Population 1 where it may be impacted by the urban or industrial footprints; and</td>
</tr>
<tr>
<td>• minimising impacts to Population 1 where it may be impacted by the infrastructure footprint.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Commitment: Maintain the long-term viability of <em>Eremophila glabra</em> subsp. <em>chlorella</em> (Critically endangered) within the Advice Area by:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• retaining (with consideration of appropriate vegetation buffers) Population 7 where it may be impacted by the urban or industrial footprints;</td>
</tr>
<tr>
<td>• minimising impacts to Population 1 where it may be impacted by the infrastructure footprint; and</td>
</tr>
<tr>
<td>• seeking to acquire and protect the bushland containing Population 1.</td>
</tr>
</tbody>
</table>
Commitment: Maintain the long-term viability of *Synaphea* sp. Pinjarra Plain (Critically endangered) within the Advice Area by:

- protecting and managing for conservation the following occurrences and known and supporting habitat where they occur in Bush Forever sites:
  - Populations 11 and 12 in Bush Forever site 350
  - Population 10 in Bush Forever Site 360; and
- minimising impacts to the following occurrences where they may be impacted by the infrastructure footprint: 4, 10, 11 and 12.

Commitment: Maintain the long-term viability of *Synaphea* sp. Serpentine (Critically endangered) within the Advice Area by:

- By protecting and managing for conservation the following occurrences and known and supporting habitat where they occur in Bush Forever sites:
  - Population 4 in Bush Forever Site 350
  - Populations 5 and 6 in Bush Forever Site 360; and
- minimising impacts to the following occurrences where they may be impacted by the infrastructure footprint: 4, 5 and 6.

Commitment: Develop and implement a survey and research program designed to gain a better understanding of the potential importance of the Perth-Peel area to (other threatened flora species and ) all priority flora species in order to inform management and conservation planning.

### 5.7.8 Additional commitments

In some areas of significant flora and vegetation, both active management and strategic rehabilitation will be required. A number of methods have been suggested by the EPA to maintain biodiversity values in the Advice Area (EPA 2015a), which are consistent with the approach of the Strategic Conservation Plan, as follows:

- Retention and protection of large consolidated blocks with lower susceptibility to threats;
- Planning for restoration of ecological communities and landscape rehabilitation;
- Strategic large scale planting of native species within the Perth and Peel regions for benefiting multiple values (State and Commonwealth matters); and
- Prioritisation of strategic rehabilitation programs serving multiple purposes to maximise the environmental benefits.

One of the key measures arising out of the Strategic Conservation Plan is the commitment to add 170,000 ha of the new areas to the conservation reserve system (both within and outside the Advice Area). This package of sites provides an important contribution to achieving the environmental
objectives for flora and vegetation, including by providing environmental offsets for significant residual impacts. Further detail is provided in Action Plan H.

Funding for on-ground management will be an important component of the conservation program. On ground management is critical for managing key threatening processes, and maintaining and ideally improving the condition of reserves.

Management actions that will benefit flora and vegetation will include activities such as:

- Revegetation and replanting within conservation areas.
- Management to address threats such as weeds, disease, uncontrolled access, fire and or feral animals for the purpose of improving habitat condition and quality.
- Ongoing management of areas outside of the Advice Area protected as offsets so they can contribute to the State’s conservation reserve system and to increase their conservation value for MNES and State environmental values.

In its interim strategic advice, EPA identified a need to better distinguish areas set aside for regional conservation purposes and those for other usages in the Regional Open Space network (EPA 2015). As a result a commitment has been made to clearly distinguish these areas in planning instruments.

<table>
<thead>
<tr>
<th>Commitment:</th>
<th>Protect key conservation sites to provide strategic protection for identified environmental values. Selected sites totalling approximately 170,000 ha will be transferred into the formal conservation reserve system as development occurs to provide secure management arrangements for long-term conservation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commitment:</td>
<td>Improve habitat connectivity and ecological linkages through provision of funding for the purpose of revegetation and replanting programs in conservation reserves, RSNA’s and other retained areas.</td>
</tr>
<tr>
<td>Commitment:</td>
<td>In relevant planning instruments clearly distinguish between areas set aside primarily for conservation and those for other purposes.</td>
</tr>
<tr>
<td>Commitment:</td>
<td>Identify and implement future management arrangements for all current and future conservation areas including those areas to be retained within the urban, industrial and rural residential footprints through future avoidance.</td>
</tr>
</tbody>
</table>

**5.8 SUMMARY OF OUTCOMES AGAINST EPA OBJECTIVE**

A quantitative analysis has been undertaken to determine the potential impact of clearing associated with the development of the proposed BRM, infrastructure, urban, industrial and rural residential footprints. The proposed development footprints intersect with Bush Forever sites, Peel RSNAs, System 6 areas, CCWs, REWs, vegetation complexes (including vegetation complexes with less than 10 per cent and less than 30 per cent [but more than 10 per cent] of their pre-European extent in the
Advice Area remaining), and Category 1 and 2 Threatened and Priority ecological communities and flora species in the Advice Area. There are commitments and processes proposed under the Strategic Conservation Plan and associated Action Plans to provide for impacts to these values to be avoided and/or minimised.

The BRM footprint has already been subject to refinement, in which approximately 13,000 ha of native vegetation in designated BRM nodes was avoided and designated as exclusion areas in which no BRM extraction can occur. Of the two key future avoidance processes (through statutory planning and refinement of the infrastructure footprint), future likely avoidance through statutory planning within the urban, industrial and rural residential footprints reduces impacts to most flora and vegetation values, although significant impacts remain. The infrastructure footprint currently is a significant contributor to these impacts on a footprint intersection basis; the final location and alignment of infrastructure is subject to a future process of refinement following detailed planning and design to further avoid and minimise impacts to environmental values.

The following potential impacts warrant key consideration during detailed planning and application of mitigation measures to ensure the EPA objective for flora and vegetation is met:

- Clearing through Bush Forever sites particularly where there is the potential for fragmentation such as the indicative proposed East Wanneroo Rail alignment through Bush Forever sites 384 and 383.
- Disturbance of CCWs for proposed infrastructure, including expansion of roads in existing reserves, and for BRM.
- Clearing of vegetation that could result in:
  - The extent of four vegetation complexes with less than 10 per cent of their pre-European extent in the Advice Area: the Guildford, Beermullah, Dardanup and Serpentine River complexes, being further reduced.
  - The extent of the Forrestfield complex, currently less than 30 per cent (but greater than 10 per cent) of its pre-European extent in the Advice Area, reduced to below 10 per cent.
  - The extent of two vegetation complexes with currently more than 30 per cent of their pre-European extent in the Advice Area remaining, the Mogumber South and Cottesloe Central and South complexes, reduced to below 30 per cent.
  - The extent of nine vegetation complexes with less than 30 per cent (but greater than 10 per cent) of their pre-European extent in the Advice Area being further reduced. These are the Swan, Yanga, Cannington, Karrakatta Central and South, Southern River, Karrakatta North, Bassendean Central and South, Reagan and Pinjar complexes.
- Potential disturbance of State listed Threatened flora species and TECs.

Some residual impacts to the aforementioned values will warrant offsets. A number of commitments are included in Action Plan G of the Strategic Conservation Plan to ensure the EPA objective for flora and vegetation is achieved, including offsets to transfer 170,000 ha into the formal conservation reserve system and to undertake revegetation and replanting programs in conservation reserves, RSNAs and other retained areas.
6 IMPACTS TO TERRESTRIAL AND SUBTERRANEAN FAUNA

6.1 KEY FINDINGS

- The proposed development footprints result in the potential clearing of 9,836 ha of native vegetation, representative of terrestrial fauna habitat. This is a substantially (62%) smaller area than originally conceived, as a result of avoidance achieved to date.

- Future likely avoidance through statutory planning is expected to further reduce requirements for clearing of terrestrial fauna habitat which should also function to reduce additional fragmentation within an already highly cleared landscape.

- Important benefits for terrestrial fauna will be provided by recovery actions outlined in species’ and communities’ recovery plans operative in the Advice Area.

- Threatened fauna species are dealt with substantively in the Commonwealth IAR. Of those that are not, the WC Act listed Carter’s Freshwater Mussel was found to be the only species highly or moderately dependent on the Advice Area. Direct and indirect impacts to the habitat of the Mussel will be managed through measures to protect wetlands and to manage hydrological impacts.

- Impacts to Priority fauna species that are poorly understood cannot yet be feasibly assessed due to significant gaps in knowledge however, commitments to additional survey and research are made that will enable a response within the frameworks established in existing and proposed mitigation.

- While no direct impacts to subterranean fauna are anticipated, indirect and cumulative impacts will be mitigated through maintenance of groundwater regimes, a range of commitments relating to the Aquatic Root Mat TEC described in the Commonwealth IAR, and a proposed expansion of Yanchep National Park.

- A number of additional commitments are made to ensure the EPA objective for terrestrial fauna is achieved including offsets to transfer 170,000 ha of fauna habitat into the formal conservation reserve system, and to undertake revegetation and replanting programs to improve habitat connectivity and ecological linkages.

6.2 EPA OBJECTIVE

The following EPA objective for terrestrial and subterranean fauna is applicable to this assessment:

“To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.”
6.3 ENVIRONMENTAL POLICY AND GUIDANCE

The following policy and guidelines are relevant to this assessment with regard to terrestrial fauna:

- The Australian Biodiversity Strategy 2010-2030 (NRMMC 2010);
- Guidance Statement No. 10 – Level of Assessment for Proposals affecting natural areas within the System 6 region and Swan Coastal Plain portion of the System 1 region (EPA 2006b);
- Guidance Statement No. 33 – Environmental Guidance for Planning and Development (EPA 2008c);
- Bush Forever (Government of Western Australia 2000);
- State Planning Policy No. 2.8 – Bushland Policy for the Perth Metropolitan Region (WAPC 2010a);
- Strategic Environmental Advice on the Dawesville to Binningup Area (EPA 2010b);
- Environmental Protection Bulletin No. 12 – Swan Bioplan – Peel Regionally Significant Natural Areas (EPA 2010a);
- System 6 Recommendations – Conservation Through Reserves Committee in the EPA Systems Red Books (EPA 1983);
- Environmental Protection Bulletin No. 20 – Protection of naturally vegetated areas through planning and development (EPA 2013a);
- Guidance Statement No. 20 – Sampling of Short Range Endemic Invertebrate Fauna for Environmental Impact Assessment in WA (EPA 2009a);
- Environmental Assessment Guideline No. 12 - Consideration of subterranean fauna in environmental impact assessment in Western Australia (EPA 2013c).

6.4 EXISTING ENVIRONMENT

6.4.1 Terrestrial fauna

Overview

Terrestrial fauna diversity and abundance in the Advice Area has significantly declined since European settlement and the urbanisation of the Perth and Peel regions. Many terrestrial fauna species that once occurred in the region are no longer present, primarily due to habitat loss and competition from introduced species. In some instances, this has led to local extinction, or extinction of entire species.

Key fauna values considered in this IAR include:

- Significant fauna habitats including those within RSNAs and CCWs;
- Ecological linkages;
- Other significant fauna species, particularly:
  - Threatened, Specially protected and Priority fauna;
Migratory species; and
- Regionally significant species (i.e. habitat specialists with limited distributions, wide-ranging species with declining populations/distributions, species at the extremes of their range or isolated populations).

The term ‘terrestrial fauna’ is used in this chapter to refer to native fauna identified as per above.

**Terrestrial fauna habitats**

For the purposes of this assessment, terrestrial fauna habitat is considered to comprise all natural and modified habitats that may be utilised by native fauna for food, shelter and movement through the landscape. The fauna habitats in the Advice Area have not been explicitly mapped; however, a number of different vegetation and landform parameters can be used to provide an understanding of the availability, connectivity and impacts to fauna habitat as a result of the proposed future development. These include:

- **Remnant native vegetation and vegetation complexes:** The retention of remnant native vegetation is important for terrestrial fauna for breeding, feeding and movement through the landscape (ecological linkages). The movement of most fauna is severely limited through heavily cleared and fragmented landscapes. Retention of large, relatively intact areas of remnant native vegetation and maintenance of connectivity between these habitats is therefore important for the survival of fauna (EPA 2015a); many native fauna species are able to persist in small, isolated remnants that provide critical habitat throughout the Advice Area. Vegetation complex mapping of the Swan Coastal Plain was completed by Heddle et al. (1980) to describe vegetation of the Darling System (System 6), and takes into account soil, landform and floristics. Some vegetation complexes are poorly represented and poorly reserved, with some already below recommended limits for retention on the Swan Coastal Plain (Figure 5-9 and Figure 5-10). Some areas of these vegetation complexes are already represented within areas identified as RSNAs and/or conservation reserves. Vegetation complexes are discussed in Section 5.7.5.

- **RSNAs,** which have been identified by the EPA as being of high conservation significance, and have the ability to support a wide range of conservation significant fauna. Within the Advice Area, RSNAs are currently represented by System 6 areas in the eastern portion, Bush Forever in the western portion and Peel RSNAs in the southern portion (refer to Section 5.7.3). Native fauna and fauna habitats associated with these RSNAs are considered to be of high conservation significance.

- **Wetlands,** including lakes, swamps, marshes, springs, damlands, tidal flats and estuaries. Ramsar wetlands and those mapped as shorebird habitat within the Advice Area have been addressed in detail in the Commonwealth IAR document. Wetlands relevant to the Advice Area listed by the EPA as CCWs or REWs are discussed in Section 5.7.4.

- **Ecological communities,** which provide important habitats for a range of fauna species, including conservation significant fauna. The majority of TECs and PECs in WA are described based on their floristic and landform characteristics, making it difficult to assess the level of dependence of conservation significant fauna on these communities. Few studies have detailed fauna species’ reliance on, or association with, particular ecological communities; however, while many relatively mobile terrestrial fauna species, such as many vertebrate species, are unlikely to rely on specific...
ecological communities, less-mobile species, such as short-range endemic invertebrates and aquatic fauna, are often dependent on a specific ecological communities for survival. State-listed ecological communities are addressed in Section 5.7.6; ecological communities listed under the EPBC Act are addressed in the Commonwealth IAR.

**Conservation significant terrestrial fauna**

The Advice Area provides habitat for a wide variety of vertebrate and invertebrate fauna, including conservation significant species listed under the WC Act and/or EPBC Act.

Conservation significant fauna species considered in this assessment are those listed as:

- Threatened (WC Act Schedule 1);
- Migratory birds protected under an international agreement (WC Act Schedule 3);
- Other specially protected fauna (WC Act Schedule 4); and
- Priority 1 or Priority 2 by Parks and Wildlife.

Species listed under Schedule 2 of the WC Act (presumed extinct) have not been discussed further in this document (refer to the assessment approach detailed in Section 4). This includes species listed as Priority 3, 4 or 5 by Parks and Wildlife.

Ninety-five conservation significant fauna species occur in the Advice Area, of which 85 are listed under the EPBC Act and have been addressed in the Commonwealth IAR.

Twelve threatened fauna species listed under the EPBC Act are addressed in the Commonwealth IAR. They include the Australasian Bittern, Australian Painted Snipe, Baudin's cockatoo, Carnaby's cockatoo, Chuditch, Forest Red-tailed Black cockatoo, Native Bee, Quokka, Short-Tongued Bee, Western Ringtail Possum, Western Swamp Tortoise and the Woylie. These species are also listed as threatened under the WC Act.

With the exception of Carnaby's cockatoo, the Commonwealth IAR concludes that impacts to these species are likely to be limited and effectively mitigated by the provisions in the Strategic Conservation Plan. Most of the species are largely avoided by proposed development, and most conservation commitments relate to the management of indirect impacts and maintenance of habitat connectivity. For Carnaby's cockatoo key potential impacts identified through the impact assessment relate to loss of high value feeding resource and habitat, habitat associated with roosting sites and resultant reduction in carrying capacity of the region. A specific conservation package for Carnaby's cockatoo is proposed that incorporates a range of further avoidance, mitigation and offset measures.

Twenty-nine EPBC listed migratory shorebirds are also assessed in the Commonwealth IAR, including two threatened species - the Curlew Sandpiper and the Eastern Curlew. The assessment concludes that impacts to these species are likely to be limited and effectively mitigated by the provisions in the Strategic Conservation Plan. Most migratory shorebird habitat is avoided by proposed development, and conservation commitments relate to the management of indirect impacts.

Further details for the assessment of the above EPBC listed threatened species and shorebirds can be found in the Commonwealth IAR and these species are not considered further in this Chapter.
Each of the remaining 10 species has been assigned to one of four categories, which reflect the relative importance of the Advice Area to each species and the depth of impact assessment undertaken (Appendix C). Impact analyses were undertaken for Category 1 and 2 fauna species. Threatened or Priority fauna species assigned to Category 3 or 4 have not been considered further as they have met a set of criteria indicating a low, or lack of reliance on potential habitat within the Advice Area. It is unlikely that these fauna species will be significantly affected by actions of the proposed future development. One Threatened fauna species and five Priority fauna species were assigned to Category 1 or Category 2 and have therefore been addressed in this document.

A full list of WC Act and EPBC Act-listed fauna species occurring in the Advice Area and the document in which they are addressed is provided in Appendix C. Descriptions of State and Commonwealth listings and rankings are provided in Appendix D.

**Consideration of climate change**

The climate of the Perth and Peel regions has been changing over the last 50 years, and has already resulted in conditions impacting some species and ecological communities (Climate Commission 2011).

Observations show that temperatures in south-west Western Australia have increased over the past century, with the rate of warming higher since 1960. Aquatic fauna, such as Carter's Freshwater Mussel and *Glacidorbis occidentalis*, are particularly susceptible to increasing temperatures, as natural aquatic environments experience very little temperature variability.

The south-west of Western Australia has experienced a 20 per cent decline in autumn and winter rainfall since the 1960s, which has subsequently resulted in a substantially larger decrease in annual runoff of over 50 per cent (CSIRO 2009). Decreases in rainfall and runoff have important implications for many wetlands, species and ecological communities which are dependent on rainfall and groundwater resources. Decreases in streamflow will have direct and indirect impacts to many fauna and ecological communities.

Increased temperatures and hot spells, coupled with reduced rainfall, have resulted in fire weather also becoming more severe. There has also been an observed six week extension of the fire season in the south-west of Western Australia. Increases in instances and intensity of fires will have negative impacts on fauna and the habitats that support them. A single fire event has the potential to wipe out an entire population of a species, particularly short-range endemics and geographically isolated populations.

### 6.4.2 Subterranean fauna

**Overview**

Subterranean fauna occur below ground and are divided into two groups as follows:

- **stygofauna** - aquatic and living in groundwater; and
- **troglofauna** - air-breathing and living in caves and voids.

Stygofauna communities are often dominated by crustaceans, whereas troglofauna communities include a wide range of taxonomic groups which have adaptations to subterranean conditions.
Stygofauna and troglofauna share the traits of reduced pigmentation and reduced or non-existent optical functionality. Research is increasingly showing that subterranean habitats contain many more species than previously recognised and that subterranean communities are a significant proportion of global biodiversity (Gibert and Deharveng 2002). Despite recent significant increases in understanding of subterranean fauna in Western Australia, the majority of information on subterranean fauna is limited and focused on species descriptions and evolutionary relationships (EPA 2012); many aspects of ecology, including reproduction, extent of distribution, dispersal, and trophic systems, are not well-studied for most subterranean fauna groups.

The subterranean fauna of Western Australia is recognised as globally significant due to high species diversity and endemism (Harvey 2002; EPA 2013c). The EPA considers the protection of both the ecosystem function and intrinsic values of subterranean fauna important. For example, it is likely that stygofauna contribute to the maintenance of water quality in groundwater aquifers (EPA 2012), but there are few studies on the consequences of loss of subterranean fauna on ecosystem function and services. The potential detrimental effects that loss of subterranean fauna could have on groundwater indicate the importance of further study and the protection of subterranean fauna biodiversity in the Perth and Peel regions.

Consistent with the assessment approach described in Chapter 4, the strategic assessment focuses on subterranean fauna and associated ecological communities that are listed as Threatened, Priority 1, or Priority 2. Due to the paucity of large-scale studies on subterranean fauna within the Perth and Peel regions, very few species and communities have been identified and listed as conservation significant.

One of the nine TECs in Western Australia relating to subterranean fauna is relevant to the Advice Area: Aquatic Root Mat Community Number 1 of Caves of the Swan Coastal Plain. This TEC is listed as Critically Endangered under the WC Act and, under the name ‘Aquatic Root Mat Community in Caves of the Swan Coastal Plain’ (DoE 2015a), as Endangered under the EPBC Act. This TEC is addressed in the Commonwealth IAR. There are no PECs relating to subterranean fauna listed by Parks and Wildlife within the Advice Area (Parks and Wildlife 2015b).

There is only one listed Threatened subterranean fauna species in the Advice Area: Hurleya sp. (WAM642-97) (Crystal Cave Crangonyctoid), which is listed as Critically Endangered under the WC Act. There are no Priority 1 or 2 subterranean fauna species listed by Parks and Wildlife within the Advice Area. The Crystal Cave Crangonyctoid is therefore the primary focus of this impact assessment.

The Crystal Cave Crangonyctoid is an amphipod crustacean and is currently known only from Crystal Cave, located within Yanchep National Park (English et al. 2003), where it occurs in association with a small area of roots that penetrate the cave waters. Crystal Cave is discussed as part of the Interim
Recovery Plan for the Aquatic Root Mat TEC due to the fact that both the TEC and the Crystal Cave Crangonyctoid are threatened and face the same threatening processes (English et al. 2003). The Crystal Cave Crangonyctoid has been classified as Category 1 on the basis that the Advice Area supports more than 50 per cent of all known records of the species. This species is one of a few Gondwanan relicts discovered in the Yanchep caves, none of which appear to have drought resistant stages (Jasinska 1997). This indicates the species is completely dependent on the presence of permanent water in Crystal Cave for survival (English et al. 2003). Given its Critically Endangered status, all known habitat and all known occurrences are considered critical for the survival of the Crystal Cave Crangonyctoid. Critical habitat for the ongoing survival of this species has been identified by English et al. (2003) as:

- Crystal Cave, its associated cave stream and pools;
- Tuart trees that have roots in the Crystal Cave stream;
- Catchment for the stream that flows through the cave;
- Areas of the Gnangara Mound between Crystal Cave and the top of the mound; and
- The superficial water table that supplies the water to the Crystal Cave stream.

**Consideration of climate change**

Subterranean fauna and associated underground caves along the Swan Coastal Plain are highly dependent on the presence of permanent water supplied by the Gnangara Mound, which is recharged via seasonal winter rainfall. Water level decline is recognised as an immediate threat to the Gnangara Mound (Valentine et al. 2009) and subsequently to subterranean fauna. Within cave ecosystems, a decline in water level directly results in a decline in species diversity (Chilcott 2013). Recent cave water level decline is particularly relevant for Crystal Cave, which supports the Crystal Cave Crangonyctoid, and is situated at a higher elevation with respect to the water table than the caves that support the TEC (English et al. 2003). Reduced cave water levels and flow reduction are predicted to worsen over the next 50 years (BoM and CSIRO 2014). A shift in land and water management techniques is essential to reduce the impacts of climate change, and ensure that groundwater recharge is maintained.

Given its heavy reliance on seasonal groundwater recharge from rainfall, and the increased demand on groundwater resources within the Advice Area due to further urban and industrial development, the Crystal Cave Crangonyctoid and its associated habitat are considered to be at high risk from impacts caused by climate change.

### 6.5 CURRENT MANAGEMENT ARRANGEMENTS

#### 6.5.1 Protection and management of fauna habitat

Protection of fauna and fauna habitat is reliant on those measures that apply to management of vegetation within the Advice Area. This includes:

- The conservation reserve system and regional parks.
- Bush Forever.
• Identification and retention of important values through planning processes (this applies to specific fauna values as well as supporting habitat).
• Management of wetlands.
• Regulation of vegetation clearing.
• Management of indirect impacts.

For more detail on these management measures refer to Chapter 5 (Flora and vegetation).

6.5.2 Protection of conservation significant fauna

Certain fauna species are afforded special protection by the State Minister for Environment or under legislation. Native animals (fauna) can be listed as Specially Protected under the WC Act and published under Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) if they are considered to be:

• under identifiable threat of extinction;
• rare; and/or
• otherwise in need of special protection.

When a species is nominated as Threatened, it is assigned a status of Critically Endangered, Endangered or Vulnerable.

Species that may be threatened or near threatened, but are data deficient, and have not yet been adequately surveyed to be listed under Schedule 1 of the Wildlife Conservation (Rare Flora) Notice, are added to the Priority Fauna List under one of the Priority levels 1-5. A full description of State listings and rankings is provided in Appendix D.

6.6 AVOIDANCE TO DATE

Significant avoidance of impacts to environmental factors was undertaken during development of the sub-regional frameworks (Section 2.2). A description of how avoidance processes conducted during the development of these frameworks has provided specific benefits for vegetation is provided in Section 5.6 and is relevant to the consideration of avoidance to date for fauna.

The key avoidance measure is location of future development in existing cleared areas in preference to uncleared areas, with impacts from future urban expansion areas greatly reduced. This will also function to reduce further fragmentation within an already highly cleared landscape.
6.7 ANALYSIS OF POTENTIAL IMPACTS

6.7.1 Future avoidance processes

Future avoidance within the proposed urban, industrial and rural residential footprints will occur through exclusion of key areas during statutory planning. Future avoidance for infrastructure footprint will occur through refinement of the footprint.

The proposed urban, industrial and rural residential development footprints will be subject to more detailed planning, including the identification of avoidance areas, to ensure retention of environmental values including fauna habitat. This process will identify proposed future avoidance zones within the currently proposed footprint boundary and result in the designation of areas of open space to retain or protect environmental values consistent with environmental policy and legislation. The actual retention/protection of these values in future will be implemented through the State’s planning processes (Section 5.5.3). Through these processes an estimated 2,200 ha of additional remnant habitat is likely to be avoided within urban, industrial and rural residential expansion areas, much of which could be considered to represent key fauna habitat including wetlands and regionally significant vegetation.

Future avoidance planning through the process outlined in Action Plan C for infrastructure also has the potential to deliver a reduction in impacts to fauna. Refinement of location will be undertaken to avoid or minimise impacts. However, this reduction is unable to be estimated at this stage.

6.7.2 Terrestrial fauna

Potential impacts

The key potential impacts to terrestrial fauna as a result of the proposed development are the direct loss of habitat and the subsequent reduction in the capacity of the Advice Area to support fauna populations. Other potential impacts include habitat fragmentation, increased mortality from vehicle strikes arising from more frequent vehicle movements, increased predation (particularly from cats and wild dogs), and altered fire regimes and hydrological processes.

Potential impacts to vegetation complexes, RSNAs, ecological communities and wetlands are discussed in the Commonwealth IAR and Chapters 5 and 8.

Impact analysis

Terrestrial fauna habitats

Potential impacts to vegetation representative of fauna habitat are discussed in Section 5.7.3 (RSNAs), Section 5.7.4 and Section 7.8.1 (wetlands), Section 5.7.5 (vegetation complexes) and Section 5.7.6 (ecological communities). Existing controls on native vegetation clearing, planning overlays controlling development in sensitive habitats and many recovery actions outlined in species’ and communities’ recovery plans operating in the Advice Area, will continue to have important co-benefits for a suite of fauna assemblages.
Threatened fauna

*Westralunio carteri* (Carter's Freshwater Mussel) is listed as Vulnerable under the WC Act and has been categorised as Category 2 based on its occurrence within the Advice Area. It is known to occur in the sandy/muddy sediments of freshwater lakes, rivers and streams, often in association with woody debris and overhanging riparian vegetation along banks and edges of dams (Parks and Wildlife 2014a). The species is very susceptible to salinity, but can survive out of water for weeks at a time (Klunzinger et al. 2011a; 2012a; Klunzinger in prep. as cited in Allen et al. 2012). Carter's Freshwater Mussel is predominantly sessile, but its parasitic larval stage acts as a means of dispersal (Morgan et al. 2011 and Klunzinger et al. 2011b as cited in Allen 2012 and Parks and Wildlife 2014a).

The species was formerly distributed from Moore River in the north to King George Sound in the south and inland to the Avon River (McMichael & Hiscock 1958; WA Museum Records; Kendrick 1976 as cited in Parks and Wildlife 2014a); however, it now occurs only within 50-100 km of the coast, from Gingin Brook southward to the Kent River, Goodga River and Waychinicup River (Klunzinger et al. 2012c and 2014 as cited in Parks and Wildlife 2014a). The recent listing of Carter's Freshwater Mussel under the WC Act is due to the rapid decline in its extent of occurrence (Parks and Wildlife 2014a). Potential impacts to Carter's Freshwater Mussel include salinisation, water extraction, drying climate, nutrient pollution and feral animals (Parks and Wildlife 2014a). Potential impacts to habitat important to Carter's Freshwater Mussel are related to direct and indirect impacts to wetlands and surface water systems (refer to Section 5.7.4 and Section 7.8).

Priority fauna

Very little is known of the habitat requirements for fauna species listed as Priority by Parks and Wildlife, and few records exist (Parks and Wildlife 2007 – 2015). Accordingly, quantitative prediction of potential impacts has not been possible. A description of each of the Priority fauna (P1 and P2) that occur within the Advice Area is provided below.

*Arbanitis inornatus* (Priority 1) is a species of trapdoor spider endemic to the south-west of Western Australia. It is currently known from three collections at Kings Park, Bullsbrook and Whitby (Parks and Wildlife 2007 – 2015). Due to some taxonomic uncertainty, this taxon is also referred to as *Euoplos inornatus* (Mark Harvey, WAM, pers. comm. 2015). *Euoplos inornatus* is known from 11 records, the majority of which occur along the Darling scarp within the Advice Area (Parks and Wildlife 2007 – 2015). The Kings Park record is the only known record of this taxon from the Swan Coastal Plain.

*Kawaniphila pachomai* (Priority 1) is a species of cricket known from only two records on NatureMap, one of which occurs within the Advice Area in Karragullen (Parks and Wildlife 2015a). The other record is from Margaret River, suggesting a large distribution of over 230 km (Parks and Wildlife 2007 – 2015). It has been collected from heathland in the Margaret River region; however, there is no information for the Karragullen record.

*Throscodectes xiphos* (Priority 1) is a species of cricket or katydid known from only four records in the Jandakot locality (Parks and Wildlife 2007 – 2015). Very little information exists for the species and its habitat requirements are poorly understood (pers. comm., Terry Houston, WAM as cited in ENV Australia 2009). The species has previously been recorded in heathland in Jandakot, potentially within Banksia woodlands (Western Wildlife 2013).
**Glacidorbis occidentalis** (Priority 2) is a species of minute freshwater snail. Very few records exist; within the Advice Area, it has been recorded from the Jarrahdale and North Dandalup areas (Ponder and Avern 2000). Its estimated distribution is approximately 60 km along the Darling scarp just south of Perth, where it is found in intermittent streams (Ponder and Avern 2000). However, records of the species also exist north-east of Collie from a lakes system (Parks and Wildlife 2007 – 2015).

**Leioproctus bilobatus** (Priority 2) is a species of native bee endemic to the south-west of Western Australia. It has been collected from between Yanchep to the north and Brookton in the south-east, including at a number of sites across the Advice Area (Terry Houston, WAM, 2015, pers. comm.). The species exhibits oligolecty (a specialised preference) for species of yellow-flowered *Gompholobium* (Terry Houston, WAM, 2015, pers. comm.).

The significant gaps in knowledge with respect to Priority fauna species preclude an accurate understanding of impact and consequently, determination of whether current mitigation measures will be adequate. Since future development for growth of Perth and Peel will occur over a long period of time, this need not be prohibitive and there is opportunity to strategically address these gaps and respond within the frameworks established in existing mitigation, and commitments made in Action Plan G.

**Management and mitigation**

Action Plan F provides a range of commitments relating to the protection of fauna species listed under the EPBC Act. Many of these commitments will provide corresponding benefits to other fauna species and habitat.

Management, mitigation and commitments in relation to vegetation (see Chapter 5) are relevant to, and will provide benefits for, terrestrial fauna and habitat. Important commitments to mitigate impacts to RSNAs include finalising the retention, protection and acquisition of the Bush Forever Program, and developing and implementing an overall strategy for the conservation and management of RSNAs in the Perth and Peel regions that identifies existing protected sites and sites to be formally protected over time.

A commitment has also been made to protect CCWs, including a new wetland buffer policy, avoidance within the urban and industrial and rural residential expansion areas. Impacts to Resource enhancement wetlands will be similarly mitigated following a review to determine those to be retained.

The maintenance and protection of terrestrial fauna habitat and ecological linkages is provided for in the planning framework through the Green Network, one of three integrated networks that together form the basis of the supporting spatial framework for future growth of Perth and Peel, identified in *Directions 2031*. The Green Network is described as the network of parks, reserves and conservation areas that support biodiversity, preserve natural amenity and protect valuable natural resources. Perth and Peel have a substantial network of regional open space that is among the largest of a metropolitan area in Australia, comprising State forests, regional and district parklands and green corridors.

The proposed future development concentrates new urban areas in cleared pastureland rather than areas with regionally significant conservation values. New urban and industrial areas will, by necessity, result in some changes to the existing landscape character of some localities, but environmental and landscape values have been considered in the identification of these areas.
Conservation measures, including offsets, will be delivered under the conservation program of the Strategic Conservation Plan described in Action Plan H. This includes protection of an initial package of sites to expand the conservation estate, ongoing additions over the life of the conservation program and on-ground measures such as rehabilitation. Offsets delivered through this mechanism will not be direct (i.e. like for like). Instead, the program focuses on delivery of prioritised actions that are strategic in nature and focus on activities that primarily have multiple environmental benefits.

A key component of the conservation program is securing management arrangements for approximately 170,000 ha of land, to be transferred into the formal conservation reserve system as development occurs. This includes reservation of further land and waterways along the Serpentine River, consolidation of the Yalgorup National Park at Lake Clifton, and expansion of Yanchep National Park, providing significant benefits for terrestrial fauna and fauna habitat values.

Urbanisation has already led to fragmentation of some natural areas, resulting in small patches of remnant vegetation that may isolate populations of native fauna. To strengthen and increase the capacity of these natural areas, the conservation program includes initiatives to rehabilitate ecological linkages (natural areas that connect these sites to one another) to assist in fauna dispersal and migration. Revegetation and replanting programs will be undertaken in conservation reserves, RSNA’s and other retained areas to improve habitat connectivity and ecological linkages.

The establishment of the Peel Regional Park is a key element in the protection of terrestrial fauna values in the Peel region. The proposed Peel Regional Park comprises terrestrial areas reserved as Regional Open Space, as well as Waterways under the Peel Region Scheme. The park will include approximately 7,800 ha of land surrounding the Peel Inlet and Harvey Estuary, as well as approximately 14,100 ha of the estuary and waterways themselves.

Protection of hydrology is a key factor in protection of some fauna species, including Carter’s Freshwater Mussel. Mitigation and commitments relating to the maintenance and protection of hydrological regimes and water quality are discussed in Chapter 7 (Impacts to Hydrological Processes and Inland Waters Environmental Quality). In particular, commitments have been proposed to protect the update the key document (Better Urban Water Management) that provides for protection of wetlands hydrology and water quality through the land planning process, require hydrological assessments to be undertaken for major rail and road projects within 50 m of a wetland and to continue to review environmental water requirements incorporated into water allocation plans.

A commitment has been made to develop and implement a survey and research program for priority fauna species. This program will be designed to gain a better understanding of the potential importance of the Perth-Peel area to priority flora species in order to inform management and conservation planning into the future. This addresses the uncertainty around these species caused by lack of available data.

Commitment: Develop and implement a survey and research program designed to gain a better understanding of the potential importance of the Perth-Peel area to Priority fauna species in order to inform future management and conservation planning.
6.7.3 Subterranean fauna

*Potential impacts*

There is no direct disturbance of the Crystal Cave karst system, nor removal of associated vegetation proposed as part of future development within the Advice Area. There is the potential for some indirect and cumulative impacts mainly relating to the reliance of the Crystal Cave Crangonyctoid on groundwater and the potential for issues relating to increased visitation to Yanchep National Park.

Limited knowledge of subterranean fauna in underground systems is also recognised as a potential threat associated with intensification of land use from the proposed future development. Mismanagement of and modifications to subterranean environments, without proper understanding of these environments, could have significant cumulative impacts to subterranean fauna (Humphreys 2006).

Subterranean fauna, including the Crystal Cave Crangonyctoid, have the potential to be affected by future planned development through the following impacts:

- Decline in groundwater quality from contamination/nutrient inflow: High nitrate levels in water have been identified as a potential pollutant risk for caves in proximity to Wanneroo Road, caused as a by-product of combustion from cars (English et al. 2003). There has been illegal dumping of rubbish within Yanchep National Park in proximity to the caves, which has been recognised as a risk for contamination to groundwater that supports the Crystal Cave Crangonyctoid (English et al. 2003);

- Changes in groundwater recharge: The underground streams that support subterranean fauna are fed by the Gnangara Mound and directly rely on the catchment for recharge and flow (English et al. 2003). Decline in water levels could lead to the drying out of underground streams that support subterranean fauna assemblages (Humphreys 2006). This was observed in Gilgie Cave in the mid-1990s, one of the caves that forms part of the Aquatic Root Mat Community TEC, which led to the fauna assemblages present within Gilgie Cave being destroyed (English et al. 2003). Conversely, increased groundwater flow could lead to flooding and erosion. Increases in water flow to caves supporting subterranean fauna could occur as a result of increased recharge or reduction in agricultural bore use on the Gnangara Mound. Increased flow is known to cause diversion of the course of underground streams, increased sedimentation, and bank erosion, and may ultimately cause cave collapse (Jasinska and Knott 1991 as cited in English et al. 2003). Increases in erosion can also lead to increased sedimentation and clogging of pore spaces in the karst systems, which can prevent movement of subterranean fauna within the cave habitats (Humphreys 2006);

- Disturbance from earthworks and land clearing for land development, or from increased access/usage of land: Disturbance to caves and subterranean fauna may result from nearby land clearing or earthworks associated with the proposed future development. Cave collapse may also potentially result from heavy human or vehicular traffic over, or in close proximity to caves (English et al. 2003); and

- Introduction of invasive species: Exotic or invasive species are primarily introduced into new environments, whether intentionally or unintentionally, by human interference. Introduced freshwater yabbies have been recorded from caves at Dongara, and are thought to have had a
significant impact on the cave fauna in that area (R. Shepherd pers. comm. as cited in English et al. 2003). Yabbies are thought to have been introduced from Victoria in the 1930s and are efficient breeders, can predate on, or compete with, native species, and can spread disease (Department of Fisheries 2012). Exotic species have the potential to impact on subterranean fauna, through predation, competition, or by habitat modification and introduction of disease.

**Impact analysis**

**Decline in groundwater quality**

Changes in groundwater quality could be expected as a result of the proposed future development, through an increase in nutrients in groundwater from fertiliser use on turf and gardens or pollution from industrial and commercial developments. This is discussed in detail in Section 7.8.3.

**Changes in groundwater recharge**

Changes is groundwater recharge are discussed in detail in Section 7.8.1. The removal of pines from the Gnangara, Yanchep and Pinjar plantations is predicted to increase groundwater levels on the Gnangara Mound. However, although significant decline in water level as a result of the proposed future development appears unlikely, continued reduced recharge from lower rainfall arising from climate change poses significant risks to subterranean fauna and their habitat from long term declines in groundwater levels.

**Disturbance**

Crystal Cave is open to the public and is visited daily by tourists to Yanchep National Park. Vandalism has also been noted in caves for which there is currently no access control in place (English et al. 2003). Changes to the cave or its environment as a result of human interference could have indirect impacts on the Crystal Cave Crangonyctoid or other subterranean fauna species. The increase in population in the Advice Area is likely to result in increased visitation to the National Park, which will require ongoing management to ensure the species’ habitat is not impacted.

**Introduction of invasive species**

An increase in population is likely to result in increased visitation to Yanchep National Park, representing a potential risk of exotic species being introduced and/or spread into the cave environments.

**Management and mitigation**

Expansion of Yanchep National Park as part of the initial package of sites to provide strategic gains for State and Commonwealth values is provided for under the Strategic Conservation Plan (refer to Action Plan H). This has been a long-standing recommendation to assist in protection of the cave habitats (Conservation Commission Western Australia 2004; DEC 2012b).

Management needs for subterranean fauna (including the Crystal Cave Crangonyctoid) within the Advice Area are primarily addressed through this expansion of Yanchep National Park, maintenance of groundwater (Section 7), implementation of the Interim Recovery Plan for the Aquatic Root Mat TEC (English et al. 2003) and the following commitments proposed for the Aquatic Root Mat TEC:
Prior to region scheme rezoning, to address potential impacts to caves and wetlands (including Loch McNess) in and adjacent to the Yanchep National Park and occurrence 1921 of the Aquatic Root Mat Community in Caves of the Swan Coastal Plain TEC, a hydrogeological assessment of the Carabooda industrial investigation area will be required to determine:

- the potential pathways of groundwater flow from this area to occurrence 1921 and other cave, karst and wetland features;
- the risk of detrimental changes in cave water levels arising from development of this area; and
- the risk of cave water contamination at occurrence 1921 and other cave, karst and wetland features arising from various possible industrial uses in this area;

If the assessment identifies a moderate or higher risk of detrimental changes in groundwater flow to or contamination of water in caves or wetlands arising from industrial uses in the Carabooda industrial investigation area, mitigation measures will be implemented to reduce this risk, which may include:

- application of appropriate setback of industrial activities;
- restrictions on types of industrial activities; and
- incorporation of drainage and water quality management controls, including engineering/interception measures.

The Interim Recovery Plan for the Aquatic Root Mat TEC (English et al. 2003) outlines regional and local priority recovery actions that are required to address key impacts to the ongoing survival of the subterranean fauna. These include management of activities within and adjacent to Yanchep National Park, as well as the Gnangara Mound catchment, fire management, and supplementation of artificial water flow to the caves if required. It also includes monitoring of cave water levels, overlying Tuart trees, and monitoring of invasive species. This management is anticipated to continue and adapt to the potential increase in visitation arising from population growth. The Interim Recovery Plan for the Aquatic Root Mat TEC also includes broader actions to manage groundwater resources such that impacts to water levels and quality do not affect the cave habitats supporting subterranean fauna.

The following actions coincide with what is proposed as an inherent part of the proposed future development under the strategic assessment and/or associated management commitments outlined in Section 7:

- **Addressing management of water levels:**
  - management of plantation pine density or removal of plantations to return groundwater recharge to levels comparable to areas of native vegetation (this is proposed under the Strategic Conservation Plan, see Action Plan E);
  - control of groundwater abstraction from the Gnangara Mound (see Chapter 7 - Impacts to Hydrological Processes and Inland Waters Environmental Quality);
  - management of future land development to the east of the caves, in consideration of groundwater flow;

- **Addressing management of water quality:**
appropriate urban water management planning to ensure waters entering caves are not polluted with fertilisers, fungicides or pesticides used in agricultural production, by runoff from urban uses, or by waters carrying pollutants from land uses such as rubbish tips or industrial areas (see Chapter 7 - Impacts to Hydrological Processes and Inland Waters Environmental Quality); and

management of future land development to the east of each of the caves, in consideration of groundwater quality.

The remaining recovery actions outlined in the Interim Recovery Plan for the Aquatic Root Mat TEC (English et al. 2003) are considered adequate to mitigate and manage potential impacts from the proposed future development.

Commitment: Expand Yanchep National Park and continue to implement measures to reduce impacts of declining groundwater levels, caused by abstraction and reduced recharge, on the Yanchep caves Threatened Ecological Community by:

- limiting/reducing water abstraction from the Superficial aquifer in the vicinity of the caves;
- limiting/reducing water abstraction from the Leederville aquifer in the northern part of the Gnangara system where this aquifer is connected to the Superficial aquifer; and
- promoting managed aquifer recharge in locations where it would benefit levels at the caves.

6.8 SUMMARY OF OUTCOMES AGAINST EPA OBJECTIVE

The key potential impacts to terrestrial fauna as a result of the proposed development are the direct loss of habitat and the subsequent reduction in the capacity of the Advice Area to support fauna populations. The proposed development footprints results in the potential clearing of 9,836 ha of native vegetation, across 38 vegetation complexes representing different terrestrial fauna habitat and assemblages. This includes areas of regionally significant vegetation and wetlands. Other potential impacts include habitat fragmentation, increased mortality from vehicle strikes arising from more frequent vehicle movements, increased predation (particularly from cats and wild dogs), and altered fire regimes and hydrological processes.

Further avoidance of impacts to fauna habitat is to be achieved through statutory planning in urban, industrial and rural residential areas and through refinement of the infrastructure footprint.

Existing controls on native vegetation clearing, planning overlays controlling development in sensitive habitats and many recovery actions outlined in species’ and communities’ recovery plans operative in the Advice Area, will continue to have important co-benefits for a suite of fauna assemblages.

Impacts to the habitat of the WC Act listed Carter's Freshwater Mussel, known to occur in the sandy/muddy sediments of freshwater lakes, rivers and streams are related to direct and indirect impacts to wetlands and surface water systems. These impacts will be managed through measures to protect wetlands and to manage hydrological impacts (see Section 5.7.4 and Section 7.8).
The significant gaps in knowledge with respect to Priority fauna species preclude an accurate understanding of impact and consequently, determination of whether current mitigation measures will be adequate. Since future development for growth of Perth and Peel will occur over a long period of time, this need not be prohibitive and there is opportunity to strategically address these gaps and respond within the frameworks established in existing mitigation, and commitments made in Action Plan G.

In regards to subterranean fauna, there is no direct disturbance of the Crystal Cave karst system habitat, nor removal of associated vegetation proposed as part of future development within the Advice Area. There is the potential for some indirect and cumulative impacts to subterranean fauna which will be addressed through the expansion of Yanchep National Park, maintenance of groundwater, implementation of the Interim Recovery Plan for the Aquatic Root Mat TEC and the commitments proposed for this TEC in the Commonwealth IAR.

In order to achieve the EPA objective for terrestrial and subterranean fauna, a number of additional commitments are included in Action Plan G of the Strategic Conservation Plan relating to offsets. This includes the transfer of 170,000 ha into the formal conservation reserve system and undertaking revegetation and replanting programs to improve habitat connectivity and ecological linkages. These offsets will be delivered under Action Plan H of the Strategic Conservation Plan.