Causeway Pedestrian and Cyclist Bridge (CPCB)

Environmental Impact Assessment (EIA)

March 2022

D13#626936
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Contents

Amendments

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1 SUMMARY

1.1 Project Information

Project Title: Causeway Pedestrian and Cyclist Bridge (CPCB) Project

Project location(s): The Causeway Pedestrian and Cyclist Bridge (CPCB) project is proposed to cross the Swan River approximately 80 – 90 m downstream of the existing Causeway bridge from Point Fraser to Heirisson Island and then to McCallum Park. The bridge will be located within the City of Perth and the Town of Victoria Park

Figure 1 shows the indicative bridge location.

Project purpose / components: The Perth Causeway shared path is a popular walking and cycling route in the Perth metropolitan area, connecting the Perth CBD and Victoria Park. The existing 2 m wide path is currently located on the western side of the two traffic bridges and has been identified as being of sub-standard width, with poor surface condition. The bridge is utilised by a mix of user groups and therefore, these factors have resulted in safety and congestion issues.

Multiple government agencies have been collaborating for many years to investigate options for developing an improved walking and cycling link across Heirisson Island. Main Roads Western Australia (Main Roads) are now proposing to deliver the new Causeway Shared Path bridge. The current preferred option is a 6 m wide bridge with cable stay design. This design would have two spans (Point Fraser span and McCallum Park span) and approximately three pylons in the Swan River.

Area proposed to be cleared: 5.74 ha out of which 4.23 ha represents planted vegetation including 0.62 ha of vegetation planted for the purposes of biodiversity conservation.

Temporary clearing required: None.

Proposed activities will be completed using Main Roads State-wide Purpose Clearing Permit CPS 818 to undertake native vegetation clearing. Details regarding native vegetation clearing and an assessment against the clearing principles are addressed separately in a Clearing Assessment Report (CAR) and Vegetation Management Plan (VMP) (TRIM Doc No.: D21#1212867).

An Environmental Impact Assessment (EIA) was undertaken to assess activities associated with the proposal and the potential impacts upon the environment.

1.2 Impacts to Key environmental aspects

The key impacts associated with native vegetation clearing associated with the proposal are as follows:

- Aboriginal Heritage Values - Two Registered Aboriginal Heritage sites were identified within the project area: The Swan River (3536) and Heirisson Island (3589). A Section 18 permit under the Aboriginal Heritage Act 1972 (AH Act) will be required as the Swan River and Heirisson island will be disturbed by project activities.
- Acid Sulfate Soils (ASS) – Project works will likely disturb river sediments to facilitate the construction of the CPCB foundations, resulting in the potential exposure of ASS.
- Native Vegetation – Clearing of 0.62 ha of vegetation intentionally planted for the purpose of biodiversity conservation.
- Threatened Fauna – Removal of 40 trees having a suitable diameter at breast height (DBH) for Black Cockatoo breeding habitat, none of which contained hollows. Clearing of 0.8 ha of negligible to low quality Black Cockatoo foraging habitat.
- Vibration - Construction of the CBCP may potentially cause vibrations of a magnitude that could affect the Causeway bridge, which is classified as a Non-Indigenous heritage site.

- Noise – the piling of the CBCP foundation within the Swan River could cause significant noise (within both the terrestrial and aquatic environments), which would negatively impact sensitive receptors including nearby residents and dolphins within the benthic environment.

The following environmental or heritage approvals, permits or licences are required to implement the project.

- A 5c licence (RIWI Act) to conduct dewatering associated with the project.
- A Section 18 under the *Aboriginal Heritage Act (1972)*.
- A Development Application under the *Planning and Development Act 2005*
- A Form 7 under the *Swan and Canning Rivers Management Act (2006)* (A Form 7 was obtained to conduct in-river surveys and investigations for the project).
- A Development Approval from the DBCA for construction works within the Swan River Trust Development Control Area.

The impacts associated with the proposed activities are not likely to be significant or warrant referral to the Western Australian (WA) Environmental Protection Authority (EPA).

1.3 Key Environmental Management Actions

The Project Environmental Management Plan Template (PEMP) refers Principal Environmental Management Requirements (PEMR's). PEMR's contain Main Roads standard environmental management actions. Where specific environmental management requirements have been identified (from approvals or by the Environmental Officer), these shall also be added to the PEMR and, noted as a specific management requirement in the PEMP.

1.4 Approvals Strategy

The approvals strategy for this project is provided in Table 1.

Table 1. Approvals Strategy

APPROVAL TYPE	Tick Yes if Applicable	APPROVAL/REF NUMBER
Statewide CPS 818	√	**CPS 818/15**
Statewide CPS817		
Project Specific Clearing Permit		
Exemption		
Environment Protection and Biodiversity Conservation Act 1999		
Environmental Protection Act 1986 – Part IV: Referral of Proposals to the Environmental Protection Authority (EPA) (Section 38)		
Environmental Protection Act 1986 – Part V; Works Approval & Licences.		
Bed and Banks Permit under the *Rights in Water and Irrigation Act (1999)*		
Section 18 under the *Aboriginal Heritage Act 1972*	√	
Other: • Development Application under the *Planning and Development Act 2005* • Form 7 and Development Approval under the *Swan and Canning Rivers Management Act 2006* • A 5c licence (RIWI Act)	√	

2 INTRODUCTION

Construction of a new pedestrian and cycling bridge adjacent to the Causeway bridge via Heirisson Island has been identified by the WA transport portfolio as a key project that will prioritise safe bicycle access to the CBD for commuters and recreational users. A number of strategic planning documents have highlighted the importance to Perth's transport future of improving this connection. These include the *City of Perth Transport Strategy (2016)*, the *Town of Victoria Park/City of South Perth Joint Bicycle Plan (2018)*, and the *Perth and Peel @ 3.5million Planning Framework (2018).*

In accordance with Main Roads' corporate Environmental Assessment, Approval and Compliance (EAAC) process, an Environmental Low Impact Screening Checklist (LISC) was completed for the proposal (Appendix A). The checklist determined that the proposal required further environmental assessment as it involves the clearing of native vegetation. Therefore, the preparation of a project specific EIA is required.

In order to evaluate the environmental impacts of the proposal, a preliminary assessment which involved a desktop analysis of environmental aspects and impacts, and also an assessment of native vegetation clearing was undertaken. The preliminary assessment determined that an Environmental Impact Assessment (EIA) is necessary to further examine those aspects with insufficient information to assess the potential impacts arising from implementation of the proposal. The EIA includes a biological survey and provides a detailed assessment and justification of whether referral to State and/or Commonwealth authorities is required. The study area is confined to a 10 km radius surrounding the proposed clearing footprint which will be referred to as the project area. Details regarding native vegetation clearing are addressed in the CAR/VMP report. As part of this assessment, consultation was undertaken with interested stakeholders to engage and inform them of the proposed activities.

3 PROJECT DESCRIPTION

The Causeway Recreational Shared Path (RSP) is a Primary Route within the Perth Cycling Network, as defined in the 2017 Western Australian Bicycle Network Plan (WABN) for cyclists and pedestrians. It is an important link providing pedestrian and cycling access to the Perth CBD from the south-eastern corridor of Perth as well as linking the recreational cycling facilities on the south and north sides of the Swan River. It provides the primary connection between Perth CBD and Victoria Park, Curtin University and Cannington, which are respectively defined as a Secondary Centre, Specialised Centre and Strategic Metropolitan Centre in the Perth and Peel @ 3.5 million planning framework.

The Causeway is one of only four pedestrian and cyclist crossings of the Swan River in the vicinity of Perth CBD, along with the Narrows, Matagarup and Windan Bridges. However, it is the 5th busiest cycling corridor in Perth, carrying approximately 1,400 cyclists and 1,900 pedestrians per day, with peak hour volumes of over 150 cyclists and 200 pedestrians.

The width of the existing shared path across the Causeway varies between 1.8 to 2.0 m, which is well below the Main Roads design standard of 6.0 m for a high-quality shared path, or 2.5 m for a low volume shared path. This substandard width, along with the poor surface condition, mix of user groups, lack of separation between the path and the road carriageway, and lack of protection for these vulnerable road users is the primary cause of safety and congestion issues for path users.

The need to improve this connection has been discussed for several decades. The 2015 WA Auditor General's Report, Safe and Viable Cycling in the Perth Metropolitan Area, identified the Causeway as the seventh-most-reported location for cyclist safety concerns. Recently, a number of strategic planning documents have highlighted the importance to Perth's transport future of improving this connection. These include the City of Perth Transport Strategy (2016), the Town of Victoria Park/City of South Perth Joint Bicycle Plan (2018), and the Perth and Peel @ 3.5 million Planning Framework (2018).

In early 2019, the Department of Transport commissioned a study to explore innovative, cost effective solutions for improving walking/cycling connectivity across Heirisson Island. Key design objectives included a desire to achieve an iconic design that values the area's natural and cultural heritage, while balancing the requirements of safety, functionality, accessibility and cost.

Following an extensive stakeholder engagement process initially to determine the preferred route alignment and subsequently to determine the preferred bridge design option, the planning project team elected to take the Tree Area Pylons option forward to next phase of (concept) design. Located 80-90 m downstream of the Causeway, this alignment was considered appropriate in terms of its ability to improve pedestrian/cyclist amenity, maintain directness and minimise impacts on flora and fauna, as well as the Swan River itself. Consisting of two cable stay bridges, the proposed option limited the number of river piers to just three, acknowledging the spiritual and cultural importance of the Swan River (Derbal Yerrigan) to Perth's First Nations peoples.

3.1 Project Location

The CPCB project occurs on Albany Highway and spans both the City of Perth, City of South Perth and the Town of Victoria Park (Figure 1. Project Area
Latitude: -31.966604
Longitude: 115.881117

The location and boundaries of the study area (10 km radius) for the project are shown in Figure 2. Project Location and Study Area

Figure 1. Project Area

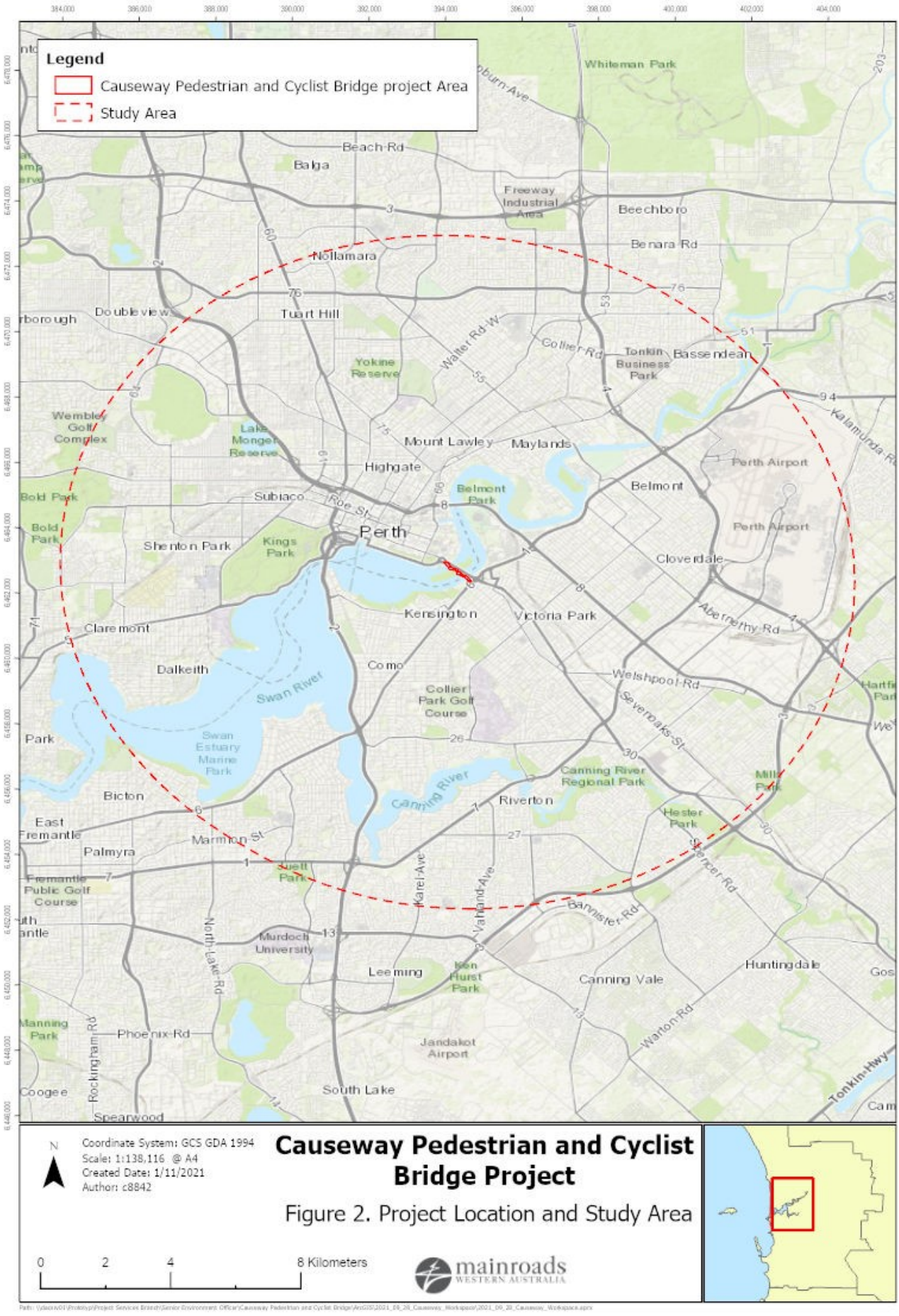

Figure 2. Project Location and Study Area

4 METHODOLOGY

4.1 Preliminary Desktop Study

A preliminary assessment of the proposal area and the potential constraints of the proposal were undertaken by viewing ArcGIS shapefiles, biological survey data, reviewing government agency managed databases and consulting with relevant stakeholders where necessary. Further details regarding the outcome of the desktop assessment are provided in the relevant Appendices.

A biological survey and a detailed environmental assessment of the project area was undertaken by AECOM (AECOM 2021a) to identify the potential impacts to vegetation clearing. The assessment determined whether this aspect may be a potential constraint associated with the proposal. Key stakeholders were also consulted to engage and inform them of the proposed activities. Information from stakeholders was considered and incorporated in this report where practicable.

Further details regarding the outcome of the assessment are provided in Sections 5 and 8.

4.1.1 Commonwealth Referral

The decision whether to refer the project to the Commonwealth Department of Agriculture, Water and the Environment (DAWE) was based upon whether the project may have a significant impact upon MNES, which are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). These include; World Heritage properties, National Heritage places, wetlands of international importance (listed under the Ramsar convention), Commonwealth land or marine areas, migratory species protected under international agreements, nuclear actions, nationally threatened species and ecological communities and water resources.

The DAWE Protected Matters Search Tool (PMST) was used to determine whether the project will have a significant impact upon MNES. Section 8 details the outcome of the search and a discussion on the report findings.

4.1.2 State Referral

The decision to refer the project to the WA EPA was based on whether the project would impact on environmental factors significantly enough to require referral under Section 38 of the *Environmental Protection Act 1986.*

5 ASSESSMENT OF ASPECTS AND IMPACTS

5.1 Aspects and Impacts

Table 2 is an evaluation of the potential impacts that the project may have on key environmental aspects. Methodology for each aspect evaluation is contained in the Main Roads Guide to Preliminary Environmental Impact Assessment and a Preliminary Clearing Impact Assessment.

Table 2. Project Aspects and Impacts

ASPECT	EVALUATION OF POTENTIAL IMPACTS
Aboriginal Heritage	The Aboriginal Heritage Risk Assessment (AHRA) identified two known heritage sites (ID 3536 and ID 3589) within the project area. The Swan River (Site ID 3536) and Heirisson Island (Site ID 3589) are registered as Mythological sites with Heirisson Island also classified as a camp, hunting place and meeting place. An overall risk rating of high was assigned to the proposed activities as ground disturbance within both sites will be required during geotechnical investigations and construction. The AHIS and AHRA are provided in Appendices B and C respectively. The AHRA determined that a s18 consent will be required for the project.
Acid Sulphate Soils	The SLIP/ASRIS database indicated that the area is classified as High to Moderate risk of acid sulfate soils (ASS) (AECOM 2021b). As dewatering or excavation below the water table is proposed, further soil investigations are required. Results from a Preliminary Site Investigation (PSI) conducted by Senversa showed that most of the project area has a high to moderate risk of ASS occurrence in the top 3 m of natural soil surface (Senversa 2021). An in-river survey is currently being undertaken and involves soil sampling pit trials near proposed excavation locations to determine the depth at which Potential ASS (PASS) is encountered and the extent of acid forming potential. The in-river survey is being conducted in accordance with DBCA requirements as approved by a Form 7 application under the *Swan and Canning Rivers Management Act, 2006*. Measures to manage ASS will be based on the outcome of the in-river survey and will be addressed in a project specific Environmental Management Plan (EMP). If excavation of ASS is likely to exceed 10 0m^3, an ASS Management Plan will be prepared in accordance with the 'Treatment and Management of soil and water in acid sulfate soil landscapes guideline' and submitted to DWER for approval prior to the commencement of site works.
Air quality	Air quality is not relevant as the construction of a pedestrian and cyclist bridge will not increase vehicle traffic within the project area. Consequently, no air quality monitoring is required during or after construction.
Contamination	A search of the DWER's contaminated sites database indicates that there is one identified contaminated site within the study area. The site is located 30 m to the east of the project area and is separated from the proposed activities by the Albany Hwy. East Perth more broadly has historically been a heavily industrialised area containing heavy polluting industries such as gasworks, coal fired power station, railway yard, engine shed, tannery, soap factory, brickworks, factories and foundries (WAM, 2021). Runoff from domestic and industrial properties has also resulted in pesticides, herbicides and excessively high nutrients entering the Swan River resulting in eutrophication and degradation of benthic communities (Larsen *et al*., 2019). Residual elevated concentrations of phosphorus, heavy metals, asbestos, and long lived herbicides and pesticides could remain in elevated concentrations within the sediments of the river banks and bed (Nice, 2009). Disturbance of the sediments of the Swan River banks and bed could therefore release contaminants into the water column. A Preliminary Site Investigation (PSI) was undertaken by Senversa in June 2021. Pre-investigation background information indicated that a section of the project area lies within a zone classified as 'Possibly Contaminated - Investigation Required' (Heirisson Island). This area is known for uncontrolled filling since the 1900s and was investigated for contaminants in previous studies (Senversa 2021). Analysis of soil samples collected at six locations to a maximum depth of 1.5 m below ground level, detected an exceedance of polycyclic aromatic hydrocarbons (PAH) compound benzo(a)pyrene in one sample on Heirisson Island. Whilst this exceedance indicates that potential risk to ecological receptors could theoretically exist during project activities, the likelihood of such risk manifesting under the current land use and layout is considered low (Senversa 2021). Indeed, no excavation will be undertaken in that area and the concentration of benzo(a)pyrene

ASPECT	EVALUATION OF POTENTIAL IMPACTS
	was only marginally above the adopted criteria and was not elevated in the underlying sample, nor was there any sign of stressed vegetation or similar in the vicinity (Senversa 2021). Measures to avoid the release of contaminants will be implemented through the project specific Environmental Management Plan (EMP). In addition, ground disturbance activities associated with the project will be managed in accordance with the management strategies outlined in Waterbank Development Site, Management Plan for the Waterbank Site (Syrinx Report Ref: RPT0813-044 Version 5, September 2013). In-river surveys with a view to investigate the water and sediment quality of the Swan River within the vicinity of the proposed new bridge is being undertaken by AECOM. The survey data will be analysed in conjunction with historical water quality datasets collected for previous in-river projects (including the Matagarup Pedestrian bridge development, as well as the regular Swan River monitoring data, where available), to provide baseline data for the project area. The in-river surveys will include assessment of water quality, sediment quality, benthic habitat and communities and ASS to determine the risk of environmental degradation associated with disturbing the river sediments when installing the bridge pylons into the riverbed. Findings from the in-river surveys will provide baseline data for water quality and sediment quality and will inform environmental management strategies. Monthly monitoring of water quality and sediment quality will also be undertaken to identify any contamination due to project activities.
Declared plants (weeds)	The biological survey conducted within the project area indicated the presence of common weeds (AECOM 2021a). Standard weed management and hygiene measures will be implemented during construction to limit the spread of existing weed species or the introduction of new weed species within the project area.
Dieback	Dieback may be an issue as the project area is located in a region that generally receives more than 400 mm of rainfall annually. The nearest weather station (Perth Metro, Station No 009225, located 3 km north-west of the project area) reported an annual average rainfall of 730.9 mm (BoM 2021). However, the NRM WA Dieback mapping tool has no records of dieback occurrence in the area. Given the built-up nature of the locality, the project area can be treated as 'Dieback Uninterpretable' as this area has been subjected to widespread historical clearing, landscaping, land reclamation and degradation. Consequently, the risk of dieback is relatively low in this area. Standard hygiene practices will be implemented to ensure that wet soil is not transported from the site to other vegetated areas. Clearing will be conducted in dry conditions as far as practicable, however if that is not possible, dieback will be managed by ensuring that earth moving machinery is clean on entry/exit, imported materials are dieback free and no movement of machinery occurs beyond the approved clearing line.
Dust	The project area is situated adjacent to sensitive receptors including medium density residential premises, parkland on Heirisson island and pedestrian foot traffic along the East Perth Foreshore and the Causeway Bridge. Dust is likely to be an issue during construction works and could impact members of the public utilising Heirisson island, the Causeway Bridge and the East Perth foreshore for travel or recreational purposes. Management measures to control excessive dust during the construction phase will be addressed in the EMP.
Groundwater	The project area lies within the Perth Groundwater Proclamation Area and a licence may be required to take groundwater. Interrogation of GIS groundwater contour data for the locality and surrounding hinterland indicates that groundwater levels are less than 1 m from the surface within the project area (AECOM 2021b).

ASPECT	EVALUATION OF POTENTIAL IMPACTS
	The project may qualify for an exemption from an abstraction licence if dewatering lasts less than 30 days and removes less than 25,000 kilolitres (AECOM 2021b). Management measures will be included in the EMP to ensure that the contractor obtains all relevant approvals and monitors and records groundwater abstraction volumes during dewatering.
Hazardous substances	Only common substances, such as fuel, oil and bitumen, will be used and works will adhere to Main Roads' standard management actions and Safety Data Sheets (SDS). Chemicals and fuel will be stored securely in double bunded storage areas and will not be stored within the predicted boundary of the 100-year ARI flood event. Storage areas will not be within 100 m of the Swan River and 50 m of the Subtropical and Temperate Coastal Saltmarsh TEC, on Heirisson island.
Heritage (non-indigenous)	The State Heritage Register (inherit database) and the City of Perth Municipal Inventory has indicated that there is one known site of heritage significance (The Causeway Bridge) within the project area and its vicinity. The Causeway Bridge is classified as a registered heritage site (Site ID: 3631) under the *Heritage Act* 2018. The project works are not expected to directly impact upon this heritage site. However, impacts from vibration will need to be considered and a dilapidation survey of the neighbouring area will be conducted for the project. Project activities involving vibration will be short-term and mitigation measures will be implemented by the contractor to avoid annoyance and discomfort to nearby residents. One such example is keeping ground vibration during construction works below the 5 mm/s threshold to minimise the risk of structural damage and human disturbance.
Land Vesting	The properties present in project area are all vested as Crown Land. The northern bank resides under the control of the City of Perth, and the Southern bank under the Town of Victoria Park. The Swan River sits under the jurisdiction of the Department of Conservation and Attractions, pursuant to the *Swan and Canning Rivers Management Act, 2006*. A Development Application will be submitted for the proposal.
Noise and vibration	Noise and vibration during construction have the potential to adversely affect the amenity of nearby sensitive receivers. The requirements of the City of Perth and Town of Victoria Park will be met with respect to noise management and construction working hours. Management measures to address noise and vibration will be included in an EMP and construction noise will be managed in accordance with the *Environmental Protection (Noise) Regulations 1997.* Stakeholder consultation will also be undertaken to manage stakeholder expectations regarding acceptable levels of noise and vibration. The Contractor will be required to address noise and vibration management measures in the project specific EMP.
Reserves / Conservation areas	A search of ArcGIS shapefiles indicates the project area intersects a River reserve (Swan River). There are no other conservation areas or reserves in the immediate vicinity of the project area. The majority of the project area also occurs within an ESA associated with the Swan River and Heirisson Island. A Development application and approval from the DBCA Rivers and Estuaries division to undertake construction within the Swan River Trust Development Control Area will be required for the project.
Surface water/drainage	A search of ArcGIS shapefiles indicated that the project area intersects the Swan River. The project area does not occur on any Proclaimed Surface Water Area or Public Drinking Water Source Area.

ASPECT	EVALUATION OF POTENTIAL IMPACTS
	Given the disturbed nature of the existing vegetation, clearing of small patches of vegetation and scattered trees/shrubs is not expected to exacerbate the incidence or intensity of flooding in the locality. Potential impacts, including surface water runoff and erosion of sediments into the Swan River will be managed during construction through the EMP and will comply with the Swan and Canning Rivers Management regulations. A Development application and approval from the DBCA Rivers and Estuaries division to undertake construction within the Swan River Trust Development Control Area will be required for the project.
Visual amenity	The proposed works are expected to result in minor and short-term visual impacts during the construction phase. Concerns raised during stakeholders consultation have been documented. Main Roads will engage with stakeholders during the design process to minimise impacts and develop an acceptable design where possible.
Wetlands	A search of ArcGIS shapefiles indicates that the project area lies within the Swan River Estuary which is a Conservation Category Geomorphic Wetland (CCW). The following project activities could potentially impact the Swan River Estuary: • Modification of the riverbanks. • Installation of three pylons within the riverbed. However, the proposed works are unlikely to significantly impact the hydrological regimes of the CCW and the following measures will be implemented to minimise any impacts: • All drainage water will be treated prior to entering the receiving water body. • If excavation of river sediments is required, the excavated sediments will be removed from the river and disposed of or reused (outside of the river) in an appropriate manner. • Silt curtains will be utilised where practical for in-river works. • Monthly monitoring of river water quality and sediment quality will be undertaken. • Post-construction hard and soft landscaping will be implemented to control erosion and sedimentation. Management of dust and surface water runoff (including acidic water derived from ASS) from construction activities associated with the project will be required to ensure that the sensitive wetland and riverine receptors within the project area are not negatively impacted. In addition, the in river baseline survey and subsequent monthly monitoring will provide data that will inform corrective management measures in the event that water quality and sediment quality of the Swan River are negatively impacted by project activities. Appropriate management measures to prevent impacts to the CCW will be addressed in EMP.
Vegetation	The project area supports 3.61 ha of planted vegetation. This vegetation was mapped as 'Mixed trees over parkland' and was ranked as being in a Completely Degraded condition (AECOM 2021a). Of this area, 0.62 ha represents native vegetation that was intentionally planted for the purpose of biodiversity conservation. An inspection of the site indicated that the vegetation occurring within the 0.62 ha consists of the following: • Riparian vegetation of *Casuarina obesa* open woodland over *Scaevola crassifolia*, *Atriplex prostrata, Rhagodia baccata* isolated shrubs over *Juncus kraussii* sparse sedgeland, fringing Point Fraser foreshore, (0.14 ha, Images 1 to 4, Appendix D). • Mixed planted native vegetation occurring as patches over lawns on Point Fraser (0.41 ha, Images 5 to 8, Appendix D). • Riparian vegetation consisting of isolated individuals of *Melaleuca lanceolata* and *Casuarina obesa* over a lawned area on the southern shoreline of Heirisson Island (0.07 ha, Images 9 to 10, Appendix D).

ASPECT	EVALUATION OF POTENTIAL IMPACTS

This vegetation is not restricted to the project area and occurs to the west over Fraser point and Heirisson Island. Clearing of this vegetation is not expected to significantly impact the already disturbed ecosystem of the locality.

Vegetation that has less than 30% remaining is said to represent an area that is significant as a remnant vegetation. The objective of the EPA is to retain more than 30% of the pre-European vegetation cover of each ecological community, as below this threshold, species loss appears to accelerate exponentially at an ecosystem level. According to Beard's mapping (Beard et al. 2013), the project area lies within Vegetation Associations 6 and 1001. Vegetation Associations 6 and 1001 have been defined as 'Medium woodland, Tuart and Jarrah' and 'Medium very sparse woodland; jarrah, with low woodland; banksia & casuarina' respectively.

As shown in the table below and Section 5.2.2.1, both Vegetation Associations 6 and 1001 have less than 30% and more than 22% of their extents remaining at the State, IBRA bioregion, IBRA subregion and local government authority. However, the Environment Protection Authority (EPA) recognises the Perth Metropolitan Region as a constrained area, which provides for the reduction of vegetation complexes to a minimum of 10% of the pre-European extent (EPA 2006). The Heddle Vegetation Complex (Vasse Complex) mapped within the project area retains approximately 31% of pre-European vegetation within the Swan Coastal Plain (table below and Section 5.2.2.2). Consequently, the Vasse Complex is not considered as a significant remnant vegetation in the locality of the project area.

Pre-European Vegetation Association	Pre-European (ha)	Current Extent (ha)	% Remaining	% Remaining in DBCA reserves
Statewide				
Vegetation Association 6	56,343.01	13,362.25	23.72	39.83
Vegetation Association 1001	56,343.01	12,660.76	22.05	14.19
IBRA Bioregion				
Swan Coastal Plain				
Vegetation Association 6	56,343.01	13,362.25	23.72	39.83
Vegetation Association 1001	57,410.23	12,660.76	22.05	14.19
IBRA Subregion				
Perth				
Vegetation Association 6	56,343.01	13,362.25	23.72	39.83
Vegetation Association 1001	57,410.23	12,660.76	22.05	14.19
Local Government Authority				
City of Perth				
Vegetation Association 6	1,377.03	332.35	24.14	96.34
Town of Victoria				
Vegetation Association 1001	1,583.57	10.46	0.66	0

<table>
<tr><th>ASPECT</th><th>EVALUATION OF POTENTIAL IMPACTS</th></tr>
<tr><td></td><td>
<table>
<tr><th>Heddle/Mattiske Veg Complex</th><th>Pre-European Extent (ha)</th><th>2013 Vegetation Extent</th><th>% Remaining</th></tr>
<tr><td>Vasse Complex</td><td>15,691.63</td><td>4,926.97</td><td>31.40</td></tr>
</table>

The 0.62 ha of native vegetation to be cleared has been planted and consequently, does not represent Vegetation Association 6, Vegetation Association 1001 or the Vasse Complex.</td></tr>
<tr><td>Biodiversity</td><td>Results from a desktop assessment indicated that there are known records of 98 significant flora species within the study area. Of these species, none were assessed as having the potential to occur within the project area due to an absence of suitable habitats. A detailed flora and vegetation survey undertaken by AECOM in November 2020 did not identify any significant flora species within the project area (AECOM 2021a). Given that no Threatened and priority species will be impacted and that the vegetation assemblage of the project area exists in patches, it is unlikely that the loss of native vegetation will significantly reduce the biodiversity of the locality.

A desktop assessment showed records of 790 significant fauna species within the study area. Many of these are historic records of species that would no longer occur within the restricted and fragmented habitats of the local region.

Three broad fauna habitats were mapped within the project area as follows:
• Scattered trees
• Parkland and maintained gardens
• Wetland, river and riparian vegetation
• Aquatic environment

The highly maintained and modified nature of the project area, coupled with the notable fragmentation and small size of vegetation patches (areas not lawned) were deemed unsuitable for mammals and medium quality to large reptiles (AECOM 2021). Only avian taxa (terrestrial species inhabiting wetlands in urbanised environments), smaller reptiles and amphibian species were considered as having the potential to occur in the locality (AECOM 2021). However, the project area does not constitute an important habitat for the establishment of migratory avian species and is likely to receive only transient visitors on their way to a more suitable environment. In addition, the regular presence of domestic dogs (Canis familiaris) within the project area is expected to be a deterrent to the persistence of fauna species (AECOM 2021). The November 2020 biological survey did not identify any significant fauna species within the project area (AECOM 2021).

No direct observations or evidence of foraging or roosting were recorded in the project area during the biological survey (AECOM 2021). The closest confirmed BirdLife Australia (2020) roosting site for the Black Cockatoo is located 600 m south-west of the project area. According to the biological survey, the fauna habitats of the project area support little biodiversity and proposed clearing comprises only 0.8 ha of negligible to low quality Black Cockatoo foraging habitat (AECOM 2021). The Black Cockatoo species are not considered to be reliant on the food source present in the project area due to the absence of plants such as Marri (Corymbia calophylla), Jarrah (Eucalyptus marginata) and proteaceous species. Better quality habitat for the Black Cockatoo species include Kings Park (approximately 3.5 km west), Bold Park (approximately 9 km north-west), and areas around Perth Airport (approximately 8 km east). Data from the biological survey also indicated that a total of 40 Eucalypt trees having a diameter at breast height (DBH) of ≥ 500 mm but with no hollows, were observed in the project area. These trees consisted of Eucalytus camaldulensis, Eucalyptus albopurpurea and introduced Eucalypt species. All of these trees were planted</td></tr>
</table>

ASPECT	EVALUATION OF POTENTIAL IMPACTS
	within the last 80 years in previously cleared parkland along the Perth foreshore and Heirisson Island. Studies have shown that hollows suitable for Black Cockatoos may not begin to appear in eucalypts until they are well over 100 to 200 years old (Johnstone et al 2013; Whitford 2002). The lack of breeding hollows along with the existing disturbance from historical clearing, ongoing recreational usage of the project area, and traffic noise from the heavily utilised Causeway Bridge, make this habitat unlikely to be utilised by the Black Cockatoo species for breeding purposes. A marine geophysics and hydrographic survey conducted by Golder in 2021 did not identify any significant benthic habitat classes (i.e seagrass or macroalgae) in the riverbed adjacent to proposed clearing. Findings from the survey indicated that the Swan River is generally characterised by bare substrate with fine/silty sands or rock rubble with no or very sparse filter feeders/macroalgae (Golder 2021). Impacts to the existing benthic community (due to increased sedimentation or contamination) are considered unlikely. Consequently, installation of the three bridge pylons is not expected to cause significant impacts to the benthic communities in the Swan River. Management measures to further reduce this risk will be addressed in the project specific EMP. It should be noted that the State and Commonwealth listed Carter's Freshwater Mussel (*Westalunio carteri)* was identified as historically occurring in the locality of the project area, although the species has not been recorded since 1905. Subsequent alteration of the river following the 1905 record has included increased sedimentation, nutrient loading, an increased extent of estuarine conditions further up the river system and influx of contamination. These changes have caused the benthic habitat surrounding Heirisson Island to become unsuitable for the occurrence of Carter's Freshwater Mussel (Kluzinger et al 2015). Consequently, this species is not expected to occur in the vicinity of the project area. Furthermore, the presence of significant turtles in the project area is not anticipated as the waterway in that locality has been heavily contaminated with pesticides, herbicides and excessive high nutrients from domestic and industrial runoff (Larsen et al. 2019). Measures to protect fauna from underwater noise and vibration impacts, including, soft-start piling procedures and stop-work procedures will be implemented in the project specific EMP. In addition, monthly monitoring of water and sediment quality upstream and downstream of project activities will be undertaken to detect any contamination caused by project activities. Given the condition of the project area, project activities not expected to have significant impacts on any fauna species or fauna habitats.

5.2 Assessment of Vegetation Clearing

For this project, a total of 0.62 ha of native vegetation will be cleared under CPS 818/15. The Clearing Assessment Report (CAR) is provided in D21#1212867.

6 ADDITIONAL ACTION REQUIRED

Table 7. Summary of Further Assessment or Approval(s) Requiredsummarises what further assessment and management is required in relation to the project.

Table 7. Summary of Further Assessment or Approval(s) Required

Aspect	Permit, Approval or Licence
Aboriginal Heritage	Section 18 consent to disturb the Swan River and Heirisson Island Aboriginal Heritage sites.
Construction	• Development Approval under the *Swan and Canning Rivers Management Act 2006.* • Development Applications under the *Planning and Development Act, 2005.*
Groundwater	5c permit to abstract water (dewatering) under the RIWI Act.
Benthic Environment	In-River investigations to identify: • Nature and extent of contamination • Ecotoxicity of contaminants identified • PASS concentration and extent • Likelihood of acidification during installation of the bridge pylons in the bed and banks of the river • Benthic habitats and ecological communities
Noise and Vibration	A dilapidation survey of the area

7 ENVIRONMENTAL MANAGEMENT

A Project specific Environmental Management Plan (EMP) for the project will be developed at a later date.

8 COMMONWEALTH ASPECTS AND IMPACTS

A preliminary assessment involving a desktop analysis of MNES and findings from the 2020 AECOM biological survey (AECOM 2021), was undertaken. Information from a PEIA prepared by AECOM (AECOM 2021b) was also integrated in the assessment of potential impacts. The assessment was used to determine whether the proposal significantly impacts on a MNES and would require referral to the Commonwealth DAWE.

The existing environment, nature and extent of impact or potential impact to the following MNES were assessed with regard to the project (Table 8). The results of the PMST are provided in Appendix E.

Table 8. Assessment of Existing Environment, Matters of National Environmental Significance and Likely Impact

MNES	EXISTING ENVIRONMENT AND LIKELY IMPACT
Nationally listed threatened species or ecological communities	Fifty-eight (58) nationally listed Threatened species and five Threatened ecological communities (TECs) were identified from the PMST Report. **Threatened Fauna** A total of 32 Commonwealth listed threatened fauna species were identified by the PMST as potentially occurring within the search area: Birds • *Botaurus poiciloptilus* Australasian Bittern • Calidris canutus Red Knot • Calidris ferruginea Curlew Sandpiper • Calidris tenuirostris Great Knot • *Calyptorhynchus banksii* subsp. *naso* Forest Red-tailed Black Cockatoo • *Calyptorhynchus baudinii* Baudin's Cockatoo • *Calyptorhynchus latirostris* Carnaby's Cockatoo • *Charadrius mongolus* Lesser Sand Plover • *Diomedea amsterdamensis* Amsterdam Albatross • *Diomedea epomophora* Southern Royal Albatross • *Diomedea exulans* Wandering Albatross • *Diomedea sanfordi* Northern Royal Albatross • *Leipoa ocellata* Malleefowl • *Limosa lapponica menzbieri* Northern Siberian Bar-tailed Godwit • *Macronectes giganteus Southern* Giant-Petrel, Southern Giant Petrel • *Macronectes halli* Northern Giant Petrel • *Numenius madagascariensis* Eastern Curlew, Far • *Pachyptila turtur subantarctica* Fairy Prion (southern) • *Rostratula australis* Australian painted snipe • *Sternula nereis nereis* Australian Fairy Tern • *Thalassarche cauta* Shy Albatross • *Thalassarche impavida* Campbell Albatross • *Thalassarche melanophris* Black-browed Albatross • *Thalassarche steadi* White-capped Albatross • *Pseudocheirus occidentalis* Western Ringtail Possum Insects • *Hesperocolletes douglasi* Douglas' Broad-headed Bee • *Leioproctus douglasiellus* Short-tongued bee

Mammals

- *Bettongia penicillata* subsp. ogilbyi — Woylie
- *Dasyurus geoffroii* — Chuditch
- *Neophoca cinerea* — Australian Sea-lion
- Pseudocheirus occidentalis — Western Ringtail Possum

Other

- *Westalunio carteri* — Carter's Freshwater Mussel

Reptiles

- *Caretta caretta* — Loggerhead Turtle
- *Chelonia mydas* — Green Turtle
- *Dermochelys coriacea* — Leatherback Turtle
- *Natator depressus* — Flatback Turtle

Threatened Flora

A total of 23 Threatened flora species were identified as potentially occurring within the study area (10 km from the project area) in the PMST search:

- *Andersonia gracilis*
- *Anigozanthos viridis subsp.* Terraspectans
- *Austrostipa bronwenae*
- *Banksia mimica*
- *Caladenia huegelii*
- *Calytrix breviseta subsp.* breviseta
- *Chamelaucium sp.* Gingin (N.G.Marchant 6)
- *Conospermum undulatum*
- *Diplolaena andrewsii*
- *Diuris drummondii*
- *Diuris micrantha*
- *Diuris purdiei*
- *Drakaea elastica*
- *Drakaea micrantha*
- *Eleocharis keigheryi*
- *Eremophila glabra subsp.* chlorella
- *Eucalyptus x balanites*
- *Grevillea curviloba subsp.* incurva
- *Grevillea thelemanniana*

	• *Lepidosperma rostratum* • *Macarthuria keigheryi* • *Synaphea sp. Fairbridge Farm* (D. Papenfus 696) • *Thelymitra stellata* **Threatened Ecological Communities** Five TECs were identified in the PMST search as potentially occurring within the study area: • Banksia Woodlands of the Swan Coastal Plain (Endangered) • Clay Pans of the Swan Coastal Plain (Critically Endangered) • *Corymbia calophylla - Kingia australis* woodlands on heavy soils of the Swan Coastal Plain (Endangered) • Subtropical and Temperate Coastal Saltmash (Vulnerable) • Tuart (*Eucalyptus gomphocephala*) Woodlands and Forest of the Swan Coastal Plain (Critically Endangered)
Justification of likely impact	Threatened Fauna . The November 2020 biological survey did not identify any significant fauna species within the project area (AECOM 2021). No direct observations or evidence of foraging or roosting were recorded in the project area during the biological survey (AECOM 2021). The closest confirmed BirdLife Australia (2020) roosting site for the Black Cockatoo is located 280 m south-west of the project area. According to the biological survey, the fauna habitats of the project area support little biodiversity and only provide 0.8 ha of negligible to low quality Black Cockatoo foraging habitat (AECOM 2021). The Black Cockatoo species are not considered to be reliant on the food source present in the project area due to the absence of plants such as Marri (*Corymbia calophylla*), Jarrah (*Eucalyptus marginata*) and proteaceous species. Better quality habitat for the Black Cockatoo species include, Kings Park (approximately 3.5 km west), Bold Park (approximately 9 km north-west), and areas around Perth Airport ((approximately 8 km east). The highly maintained as well as the modified nature, fragmentated and small size of the vegetation patches (areas not lawned) within this habitat type is generally considered unsuitable for mammals and for medium to large reptiles (AECOM 2021a). This area is mostly suitable to avian taxa, smaller reptiles and amphibian species. The regular presence of domestic dogs (*Canis familiaris)* within the project area is also expected to be a deterrent to the persistence of fauna species. Data from the fauna survey also indicated the presence 40 Eucalypt trees having a DBH ≥ 500 mm but with no hollows. These trees consisted of native and exotic *Eucalyptus* species that were planted within previously cleared parkland along the Perth foreshores and Heirisson Island. The lack of breeding hollows along with the existing disturbance from historical clearing, ongoing recreational usage of the project area, and traffic noise from the heavily utilised Causeway Bridge, make this habitat unlikely to be utilised by the Black Cockatoos for breeding purposes. In addition, the project area was found to provide 0.8 ha of negligible to low quality Black Cockatoo foraging habitat. However, no direct observations or evidence of foraging or roosting were recorded in the project area (AECOM 2021a). The State and Commonwealth listed Carter's Freshwater Mussel (*Westalunio carteri)* was identified as historically occurring within the locality of the project area, although the species has not been recorded since 1905. Subsequent alteration of the river following the 1905 record has included increased sedimentation, nutrient loading, an increased extent of estuarine conditions further up the river system and influx of

	contamination (AECOM 2021a). These changes have caused the benthic habitat surrounding Heirisson Island to become unsuitable for the occurrence of Carter's Freshwater Mussel (Kluzinger, *et al.*, 2015). The presence of Threatened turtles in the project area is not anticipated as the waterway in that locality has been heavily contaminated by pesticides, herbicides and excessive high nutrients from domestic and industrial runoff (Larsen *et al*., 2019). Consequently, clearing within the project area is not expected to have any significant impacts on any Threatened fauna species or fauna habitats. <u>Threatened Flora</u> The number of significant species identified is reflective of the inclusion of several significant patches of remnant urban vegetation within the study area, including Kings Park, Bold Park, Herdsman Lake, Brixton Wetlands and Canning River Regional Park. The likelihood assessment determined that no species listed as Threatened under the EPBC Act was likely to occur within the project area due to the extensive clearing, lawned areas and planted nature of the vegetation occurring in the locality. No Threatened flora species were also recorded during the AECOM biological survey (AECOM 2021a). <u>Threatened Ecological Communities</u> None of the five TECs identified in the PMST are expected to occur as the site to be cleared consists solely of planted vegetation. The 2020 biological survey (AECOM 2021a) confirmed that there are no TECs in the project area. During the 2020 biological survey, the Subtropical and Temperate Coastal Saltmarsh TEC was recorded 35 m west of the project area on Heirisson Island. Given the very minor amount of clearing proposed, no significant indirect impacts to this TEC due to factors such as increased sedimentation, turbidity or contamination are anticipated. In addition, no excavation below the water table will be undertaken within Heirisson Island. Precautionary management measures to avoid any impacts to the Subtropical and Temperate Coastal Saltmarsh TEC will be addressed in the project specific EMP. Project activities will therefore not directly or indirectly impact nationally threatened species or communities.
Methodology	AECOM 2021a AECOM 2021b DAWE PMST Report SPRAT profile

Migratory species	Forty-nine (49) nationally listed migratory species were identified from the PMST Report. <u>Marine birds: 13 species</u> <u>Terrestrial birds: one (1) species</u> <u>Wetland birds: 28 species</u> <u>Marine: seven (7) species</u>

Justification of likely impact	No nationally listed migratory species were recorded during the 2020 Biological survey (AECOM 2021a). The habitat of the project area does not constitute an important habitat for the establishment of migratory species and is likely to receive only transient visitors on their way to a more suitable environment (AECOM 2021a). In addition, the project area is an integral part of Point Fraser, Heirisson Island and McCallum Park which are well known recreational areas in the locality with many visitors on a daily basis. Given the lack of suitable habitat in an area that supports recreational activities, the presence of migratory bird species as permanent residents with continual breeding populations is not anticipated. Moreover, none of the seven marine species identified in the PMST are expected to occur in the waterway occurring in the project area due to the polluted nature of the locality. In any case, disturbance within the Swan River due to the installation of pylons will be temporary and measures will be addressed in the EMP to avoid any impacts to marine species. Project activities are unlikely to impact on any migratory species.
Methodology	AECOM 2021a AECOM 2021b DAWE PMST Report

Wetlands of International Importance	One wetland of international importance, the Forrestdale and Thomsons Lakes, was identified in the PMST report.
Justification of likely impact	This wetland is located 20 km south-west of the project area and given the distance, it is unlikely that project activities will impact the Forrestdale and Thomsons Lakes.
Methodology	DAWE PMST Report

World Heritage Properties	No world heritage properties were identified from the PMST Report.
Justification of likely impact	As no World Heritage properties were identified within the study area, it is unlikely that project activities will impact any world heritage values.
Methodology	DAWE PMST Report

National Heritage Places	No national heritage places were identified from the PMST Report.
Justification of likely impact	As no significant places were identified within the study area, it is unlikely that project activities will impact any national heritage places.
Methodology	DAWE PMST Report.

Commonwealth Land or Marine Areas	No Commonwealth Land or Marine Areas identified from the PMST Report.
Justification of likely impact	Proposal activities are not located within or near Commonwealth land or marine areas. Commonwealth land or marine areas will not be impacted by the activities associated with the project.
Methodology	DAWE PMST Report. .

Nuclear Actions	Not relevant to the proposed activity.
Justification of likely impact	The project activities do not involve nuclear actions and this aspect is not relevant to the project.
Methodology	DAWE PMST Report.

Water Resource	Not relevant to the proposed activity.
Justification of likely impact	The project activities do not involve a coal seam gas development or a large coal mining development.
Methodology	DAWE PMST Report.

9 SUMMARY OF SURVEY/ASSESSMENT

Causeway Pedestrian & Cyclist Bridge Biological Survey (AECOM 2021)

AECOM was commissioned to undertake a biological survey for the Causeway Pedestrian & Cyclist Bridge proposal which lies within Point Fraser, Heirisson Island and McCallum Park. The objective of the biological survey was to delineate key flora, vegetation, fauna and wetland values of the survey area to inform the environmental assessment and approval process.

AECOM completed a detailed flora and vegetation assessment in November 2020. Areas of native vegetation were traversed on foot and subjected to detailed surveys including flora quadrats and opportunistic recordings. A basic fauna and targeted black cockatoo survey was completed in November 2020. The basic fauna survey primarily focused on verifying the findings of the desktop assessment and mapping fauna habitat, while also searching for signs of significant fauna species. The targeted black cockatoo survey was conducted to identify potential breeding, roosting and foraging habitat.

Findings of the biological survey:

A total of 29 native flora species were recorded representing 19 genera and 8 families. The families Chenopodiaceae and Myrtaceae represented the majority of the native species recorded. Seven introduced species were recorded, including *Melaleuca quinquenervia,* commonly known as the broad-leaved paperbark, and *Casuarina cunninghamiana* subsp. *cunninghamiana,* commonly known as river sheoak, both of which have been widely cultivated and often planted in parklands.

No threatened flora listed under the EPBC Act or *Biodiversity Conservation Act 2016* (BC Act) were recorded during the survey. In addition, no native endemic species listed as Priority by DBCA were recorded in the project area and broader survey area. During the survey, the Subtropical and Temperate Coastal Saltmarsh Threatened Ecological Community (TEC) was recorded on Heirisson Island fringing the artificial wetland on the southwest side. The vegetation assemblage of this TEC is the only native vegetation occurring in the survey area and was mapped as vegetation type CoSq. Vegetation type CoSq has been defined as a riparian vegetation that is in 'Good' condition, but generally lacking floristic diversity, suffering from weed invasion and having areas with cleared access paths. The Subtropical and Temperate Coastal Saltmarsh TEC was not recorded in the project area.

Three broad fauna habitats were defined and mapped, based predominantly on vegetation, landform and soils. These comprised Scattered Trees; Wetland, River and Riparian Vegetation; and Parkland and Maintained Gardens.

Thirty-three vertebrate fauna species were recorded during the field survey, comprising 31 bird and two mammal species. A large majority of these species were wetland and waterbird species,
A total of 416 native and introduced eucalypts with a diameter at breast height (DBH) ≥ 500 mm were observed and only one of these trees had a hollow of a suitable size for Black Cockatoo breeding purposes. However, there was no direct or indirect evidence for the presence of Black Cockatoo within the survey area. Data from the survey showed the presence of 40 eucalypt trees with a DBH ≥ 500 mm in the project area and none of these trees had any hollows. The habitats present were described as providing negligible to low quality value foraging habitat for Black Cockatoo species.

Further details regarding the biological survey are provided in Appendix F.

Preliminary Site Investigation – Proposed Causeway Pedestrian and Cycle Bridge (Senversa 2021)

Senversa Pty Ltd (Senversa) was commissioned by Main Roads Western Australia (MRWA) to undertake a Preliminary Site Investigation (PSI) with limited soil sampling of the proposed Causeway Pedestrian and Cyclist Bridge (CPCB) project area (hereafter referred to as the 'site').

Pre-investigation background information indicated that there are a number of known or suspected contaminated sites under the *Contaminated Sites Act 2003* (*CS Act*) adjacent to, or within, the site (such as Heirisson Island, classified as *Possibly Contaminated - Investigation Required* [PCIR]).

The aim of the Preliminary Site Investigation (PSI) was to provide MRWA with a preliminary characterisation of the contamination status of the site to assess its risk to human health, the environment and support considerations related to future construction management and regulatory compliance associated with the CPCB project.

The specific objectives of the PSI as stated by MRWA were to:

- Identify and summarise potential sources of contamination as a result of current and historical activities.
- Identify naturally occurring substances [acid sulfate soils (ASS) within the site boundary.
- Determine the associated potential risks to human health, the environment and environmental value.
- Outline requirements for further assessment of potential contamination, where applicable.

In order to fulfil the objectives stated above, the following scope of work was undertaken:

- A desktop review of relevant publicly available information.
- A site inspection.
- Collection and analysis of limited selected soil samples at a National Association of Testing
- Authorities (NATA) accredited laboratory for the required analysis.
- Development of a preliminary conceptual site model (CSM) that provided a synthesised
- description of issues identified; and
- Completion of this PSI report consistent with Department of Water and Environmental Regulation (DWER) guidelines.

Findings of the survey

The key investigation findings were as follows:

- Land abutting the Swan River foreshore has been used as parks and public open space generally for a number of decades. This land has been variously filled and reclaimed using uncontrolled fill since the early 1900s.
- Studies nearby including the nearby Waterbank project to the northeast have variously identified contaminant concentrations in fill exceeding adopted human health and ecological screening criteria. These studies may in particular be indicative of potential fill, groundwater and porewater quality present beneath the northern portion of the notional bridge footprint (Point Fraser).
- Heirisson Island was originally a group of small swampy islands on a shallow portion of the Swan River, which were subsequently infilled to create Heirisson Island in its current form. Heirisson Island is classified as PCIR under the CS Act due to historical landfilling with the desktop assessment identifying anecdotal evidence of fly-tipping type waste (e.g. concrete blocks, rubble, auto parts) in the 1970s (however a municipal landfill or similar was not specifically identified).
- A review of a historical sediment contamination assessments of Swan and Canning estuaries indicates that sediments collected from an upstream location in Burswood (approximately 1 km northeast from the centre of the notional bridge footprint) contained elevated concentrations of polycyclic aromatic hydrocarbons (PAHs), metals (zinc and lead) and pesticides (dieldrin) in excess of adopted Tier 1 screening criteria.

- Historical sediment assessments further upstream in Claisebrook Cove, East Perth also identified elevated contaminant concentrations in the form of total recoverable hydrocarbons (TRHs), PAHs and pesticides. Such contamination was attributed to the long history of pollution in this area, including most notably the historical presence of the former East Perth Gasworks immediately north of Claisebrook Cove. TRH and PAH contaminated sediment was also encountered during the construction of Matagarup Bridge.
- Most of the site and surrounds has a high to moderate risk of ASS occurrence in the top 3 m of natural soil surface. ASS may be variously present in fill (and naturally beneath fill) depending on the source of fill (eg. Swan River dredging).
- A preliminary soil characterisation undertaken during the PSI, entailing the sampling and analysis of six soil samples from three soil bores to 1.5 m below ground level (bgl), identified the presence of PAH compound benzo(a)pyrene in one sample exceeding the adopted ecological screening criteria. Peak concentrations of all other contaminants of potential concern (CoPCs) remained below the adopted Tier 1 screening criteria. Noting the preliminary nature of the soil characterisation deeper fill may be present of variable quality.
- Whilst an exceedance of Tier 1 soil screening criteria indicates a potential risk to ecological receptors could theoretically exist, the likelihood of such risk manifesting under the current land use and layout is considered low given the concentration of benzo(a)pyrene was marginal above the adopted criteria and was not elevated in the underlying sample, nor was there any sign of stressed vegetation or similar in the vicinity.
- Groundwater quality was not directly assessed and may be degraded as a result of uncontrolled filling and associated leaching.

Based on the findings from the desktop review, site inspection and limited soil investigation the following two areas of potential environmental concern (APECs) were identified:

APECs	Contaminants of Potential Concern
Uncontrolled filling on Heirisson Island, Point Fraser, McCallum Park	• Metals • Asbestos • Nutrients (e.g. nitrogen, phosphorus) • Petroleum hydrocarbons (TRH/BTEX) • PAH (e.g. benzo(a)pyrene) • Landfill gases (e.g. methane) • Phenols • Pesticides • ASS
East Perth Swan River sediments and pore water	• TRH • PAH & Phenols • Metals • Pesticides • Asbestos • Nutrients (e.g. nitrogen, phosphorus) • ASS

Depending on the nature of the source and the disturbance during CPCB construction, a range of potentially complete source-pathway-receptor (SPR) linkages could arise. If contamination and or ASS is encountered, it is likely that the most significant risks would relate to Swan River water quality and associated ecological receptors.

Further details regarding the PSI are provided in Appendix F.

10 RECOMMENDATIONS FOR FURTHER ASSESSMENT

No further survey(s) or assessment(s) are needed as part of the project activities. The project will be implemented in accordance with the project specific EMP that will be developed at a later stage.

11 STAKEHOLDER CONSULTATION

Further stakeholder consultation will be required prior to the commencement of project activities. To date, the following stakeholders were consulted for the project:

- City of Perth
- Department of Biodiversity, Conservation and Attractions (DBCA)
- Department of Planning, Lands and Heritage (DPLH)
- Department of Transport (Marine)
- Office of the Government Architect (OGA)
- Town of Victoria Park
- Traditional Owners

12 DECISION TO REFER

12.1 Referral to the Department of Agriculture, Water and the Environment (DAWE)

The preliminary impact assessment determined that the proposal will not have a significant impact on MNES or impact Commonwealth land as outlined in Table 8 of the report. For this reason the proposal does not require referral to the Commonwealth DAWE.

12.2 Referral to the Environmental Protection Authority

The preliminary impact assessment determined the project will not require referral to the WA EPA.

This is due to the low significance of its impacts to the surrounding environment and that it is unlikely the project will generate significant public interest.

13 CONSTRAINTS MAPPING

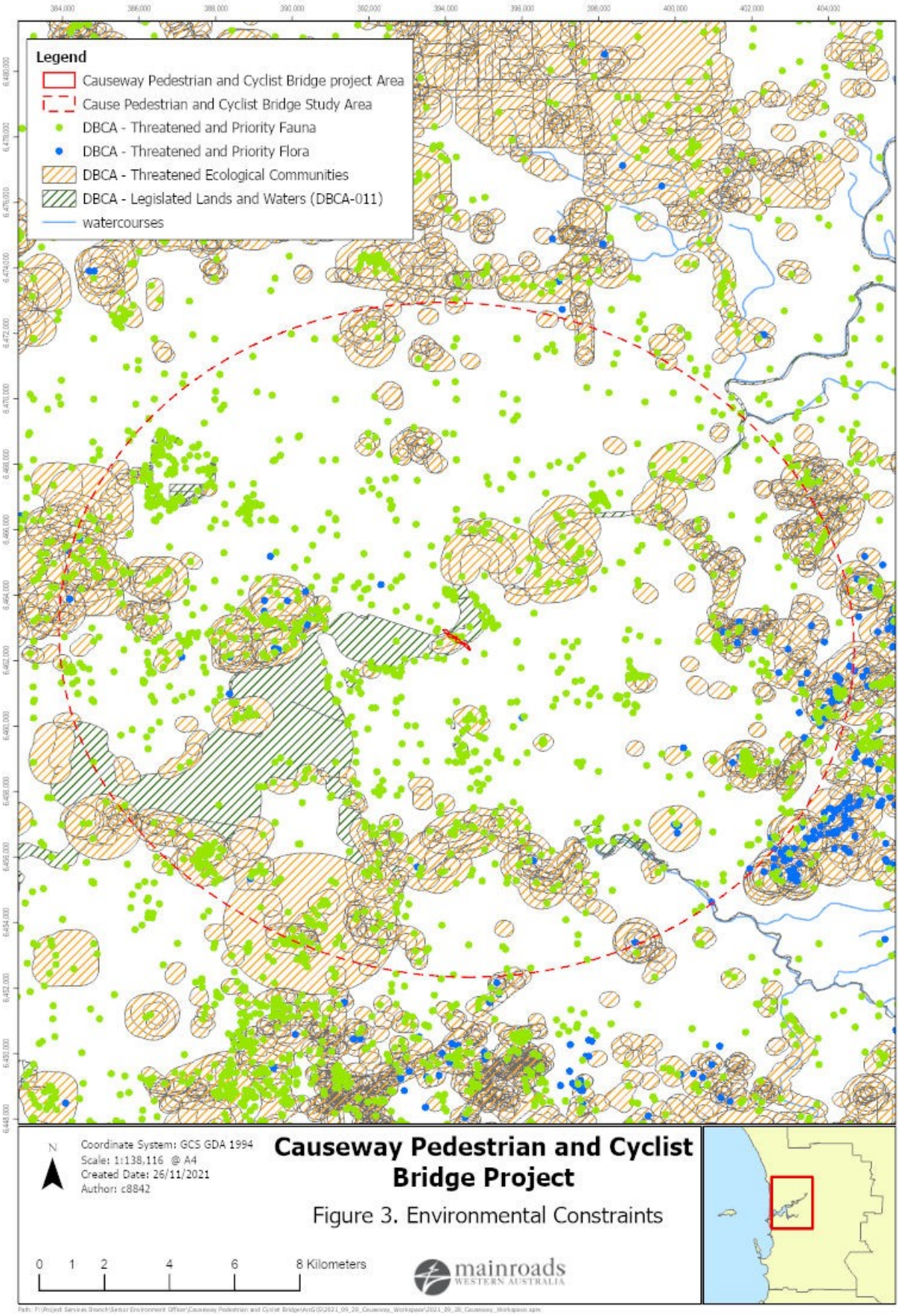

Figure 3. Environmental Constraints Associated with the Project Area

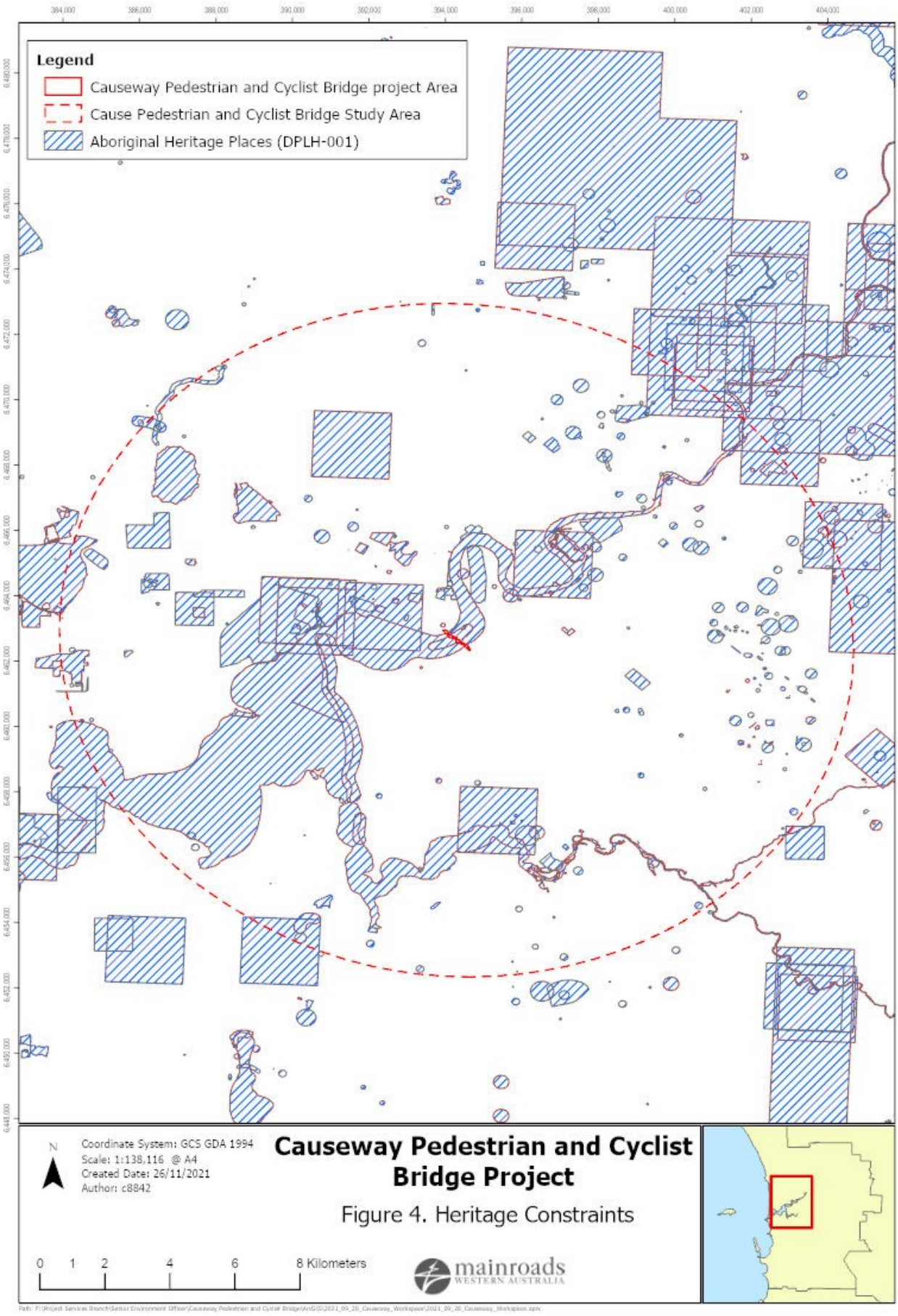

Figure 4. Heritage Constraints Associated with the Project Area

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15 APPENDICES

Appendix	Title
Appendix A	Environmental Low Impact Screening Checklist
Appendix B	Department of Planning, Lands and Heritage AHIS Search
Appendix C	Aboriginal Heritage Risk Assessment
Appendix D	Site Photos
Appendix E	DAWE Protected Matters Database Search
Appendix F	Biological Survey and Preliminary Site Investigation

Appendix A: Environmental Low Impact Screening Checklist

LISC - D21#191050

Environmental Low Impact Screening Checklist (LISC)

The Environmental Low Impact Screening Checklist (LISC) is part of the Main Roads corporate Environmental Assessment, Approval and Compliance Process. All proposed projects and associated activities must be screened to identify those that are low impact. Activities (e.g. extraction of road building materials) that are not included in the project scope during initial screening must be screened separately.

1. **Section 1: Project Scope –** to be completed by the Project Manager (PM) and sent to an Environmental Officer (EO) for review. Changes in a project's scope will require re-screening and a revised checklist.
2. **Section 2 & 3: Screening Assessment of Project Scope –** to be completed by the EO. Submit the LISC to the Central Review and Submissions Process (CRSP) role or delegate via: LISCandAHRA@mainroads.wa.gov.au
3. **Section 4: Review and Endorsement –** the CRSP role or delegate will review the LISC and provide endorsement. Further comments or recommendations may be provided for the EO to address.

SECTION 1: PROJECT SCOPE

Project Details

Project Name:	Causeway Pedestrian and Cyclist Bridge (CPCB)		
Region/Directorate:	Infrastructure Delivery Directorate (IDD)		
Local Government Authority	City of Perth and Town of Victoria Park		
Road/Bridge Name & No:	Adjacent to the Causeway (H726; bridges 0932 & 0914)		
Project Location (SLK):	NA		
TRIM Link to Spatial Data:	D21#190779		
EOS No:	2204		
Expected Project Start Date:	2022		
Project No:	21117040	**Task Code:**	19301
Workflow Stage Name:	Develop (but Delivery procurement process commenced 29 January'21)		
Project Justification	The width of the existing shared path across the Causeway varies between 1.8 to 2.0 m, which is well below the Main Roads design standard of 6.0m for a high quality shared path, or 2.5 m for a low volume shared path. This substandard width, along with the poor surface condition, mix of user groups, lack of separation between the path and the road carriageway, and lack of protection for these vulnerable road users is the primary cause of safety and congestion issues for path users.		

Project Description

The Causeway Pedestrian and Cyclist Bridge (CPCB) project involves the provision of a new active transport river crossing linking East Perth to Victoria Park via Heirisson Island. Comprising of two cable stay bridges, the proposed crossing will be located approximately 80-100m downstream of the existing Causeway traffic bridges. The design and alignment were chosen after an extensive stakeholder consultation and options assessment process managed by the Department of Transport in 2019.

In August 2020 the State Government announced funding towards the construction of the bridge which was to be further developed and constructed by MRWA. The scope of the project includes:

- Two cable stayed bridges with 2 piers in the McCallum Park bridge and 1 pier in the Point Fraser bridge.
- 6.0 m wide separated path
- Bridge design is acknowledgement of Aboriginal history and culture.
- Increased navigational clearances for both structures in particular the Point Fraser structure i.e. the primary river navigational channel.
- Bridge alignment to minimise the impacts to trees on McCallum Park, Point Fraser and Heirisson Island.
- Bridge material proposed is weathering steel but is subject to further investigation.

Modifications to the existing traffic bridges is not included in the scope of works.

Scoping Questions

Consider discussing these questions with your EO. If an item is unknown, tick yes.

Item No.	Question	Yes	No
1.	Will the project involve the clearing of vegetation? This includes access tracks, side-tracks, turn-around areas, road building material sources, turkeys nests, stockpile locations, storage of machinery, relocation of services, fences and laydown areas.	☐	☒

Project Components	**Tick yes if clearing relevant**
Road Widening/Overtaking lanes/Realignment	☐
Intersection Upgrades	☐
Public Shared Pathways (PSP)	☐
Material Pits	☐
Access/Side Tracks	☐
Connecting Roads	☐
Pre-construction works/service Relocations	☐
Bridges/Structures	☐
Stockpiles Aggregate/Waste/Material	☐
Camp sites	☐
Fencing	☐
Other	☐
Estimate Total Clearing (ha)	0

Note: Clearing includes pruning that severs stems or trunks. Native vegetation includes all indigenous aquatic and terrestrial vegetation, dead or alive, and planted vegetation if it was required under a legislative requirement.

No clearing of native vegetation will occur for the Project. The large trees and vegetation within the Project area and on Hierisson Island have all been classified as planted.

2.	Will the proposed works involve the excavation of soils? If yes, provide details: *Depth & volume to be confirmed and will include excavation of in-river soils.*	☒	☐
3.	Will the project require the extraction or movement of soil, or the clearing of vegetation in conditions other than dry conditions and is it located in any part of a region that has an average annual rainfall of greater than 400mm and is south of the 26th parallel? ? *Note: Dry soil conditions is when soils (not dust) do not freely adhere to rubber tyres, tracks, vehicle chassis or wheel arches.*	☒	☐

4.	Will the project pass over, adjoin or drain into a waterway or wetland, or alter the local hydrology? *Note: waterways refers to any river, creek, stream or brook, including its floodplain and estuary. This includes systems that flow permanently, for part of the year or occasionally; and parts of the waterway that have been artificially modified.*	☒	☐
5.	Will the project involve the processing (including screening, washing, crushing grinding, milling, sizing, separating and/or screening) of more than 5,000 tonnes of Main Roads road-building materials per year? If yes, provide an approximate quantity and rate:	☐	☒
6.	Will the project require the extraction of water from an existing Main Roads / private bore, the installation of a new water bore or extraction of water from a surface water body? If yes, provide details: *Swan River*	☒	☐
7	The project is located within close proximity to a residential area and works are to occur outside normal working hours. Normal working hours: Mon to Sat 7:00am - 7:00pm.	☒	☐
8	• Will the project require activity within DBCA estate OR • Will the works be requiring clearing of vegetation adjacent to DBCA estate?	☒	☐

Completed by:	
Name	Adrian Minogue
Job Title	Project Manager Development
Date	18 February 2021

Once Section 1 is completed, send the LISC to your EO to complete Section 2.

SECTION 2: SCREENING ASSESSMENT OF PROJECT SCOPE	
Based on the information provided in Section 1, is it likely that this project requires further assessment? *Tick relevant boxes*	
☐	**NO**, the PM has ticked no to all the questions above, and the EO considers further assessment is not required. The project can be managed through Principal Environmental Management Requirements (PEMR) or a Construction Environmental Management Plan (CEMP).
☐	**NO**, although the PM has ticked yes to one (or more) of the questions above, the EO considers further assessment is not required. *The EO must provide justification in Appendix 1.*
☐	**YES**, further assessment required through a Project Environmental Risk Assessment (PERA).
☐	**YES**, further assessment through Clearing Desktop Report (Short Form). *The EO must demonstrate the clearing meets the "When to use" a short form assessment criteria as outlined in D17#452322*
☐	**YES**, further assessment required through either a Clearing Desktop Report (CDR) or Clearing Assessment Report (CAR).
☒	**YES**, further assessment required through a Preliminary Environmental Impact Assessment (PEIA)/ Environmental Impact Assessment (EIA) as the project has the potential to be referred to the State and/or Commonwealth.

Section 3: Likely Clearing Approval		
Based on the information provided in Section 1, select likely Clearing Approval pathway		
☐ CPS 818	☐ CPS817	☐ Project Specific Permit
☐ Schedule 6 Exemption	☐ Other	☐ Bed and Banks Permit

☐ Exemption under Regulation *(insert exemption e.g. Reg 5 Item 22)*

Select below, and provide evidence (i.e. photos or map), if clearing is:

☐ not within a mapped ESA, or

☐ within a previously cleared maintenance zone

Provide further justification regarding utilisation of exemption below:

Clearing of native vegetation is not required.

Completed by:	
Name	Fiona van Rijnswoud
Job Title	Environment Officer
Date	18 February 2021

Once Section 2 is completed, the EO is to send to the LISC to CRSP, at liscandahra@mainroads.wa.gov.au, for their review and endorsement.

SECTION 4: REVIEW AND ENDORSEMENT

Review Comments

I agree with your recommendation that no further assessment under CPS 818 is required as no clearing of native vegetation is proposed. If clearing is required an additional LISC must be submitted.

Given the other potential impacts associated with these works I agree with your recommendation that a PEIA/EIA will be required.

Reviewed and Endorsed by:

Name	Clare Collett
Job Title	SEO
Date	02/03/2021

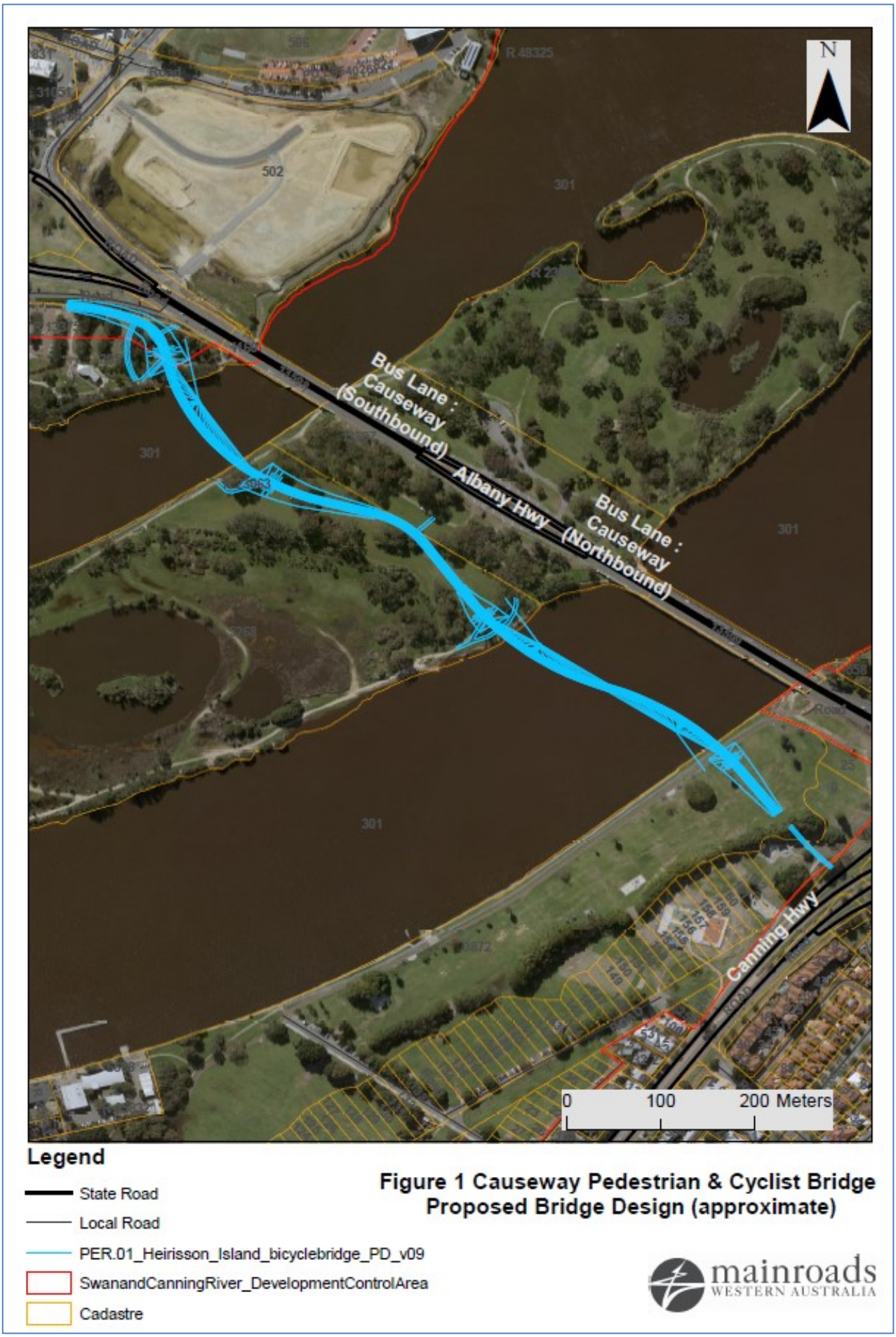


Figure 1: Proposed Causeway Pedestrian and Cyclist Bridge Design

Appendix B: Department of Planning, Lands and Heritage (DPLH) AHIS Search

AHIS Searches (D21#214972, D21#214975, D21#214977)

Aboriginal Heritage Inquiry System

List of Registered Aboriginal Sites

Search Criteria

4 Registered Aboriginal Sites in Shapefile - Heritage_Survey_Area30092020

Disclaimer

The *Aboriginal Heritage Act 1972* preserves all Aboriginal sites in Western Australia whether or not they are registered. Aboriginal sites exist that are not recorded on the Register of Aboriginal Sites, and some registered sites may no longer exist.

The information provided is made available in good faith and is predominately based on the information provided to the Department of Planning, Lands and Heritage by third parties. The information is provided solely on the basis that readers will be responsible for making their own assessment as to the accuracy of the information. If you find any errors or omissions in our records, including our maps, it would be appreciated if you email the details to the Department at AboriginalHeritage@dplh.wa.gov.au and we will make every effort to rectify it as soon as possible.

South West Settlement ILUA Disclaimer

Your heritage enquiry is on land within or adjacent to the following Indigenous Land Use Agreement(s): Whadjuk People Indigenous Land Use Agreement.

On 8 June 2015, six identical Indigenous Land Use Agreements (ILUAs) were executed across the South West by the Western Australian Government and, respectively, the Yued, Whadjuk People, Gnaala Karla Booja, Ballardong People, South West Boojarah #2 and Wagyl Kaip & Southern Noongar groups, and the South West Aboriginal Land and Sea Council (SWALSC).

The ILUAs bind the parties (including 'the State', which encompasses all State Government Departments and certain State Government agencies) to enter into a Noongar Standard Heritage Agreement (NSHA) when conducting Aboriginal Heritage Surveys in the ILUA areas, unless they have an existing heritage agreement. It is also intended that other State agencies and instrumentalities enter into the NSHA when conducting Aboriginal Heritage Surveys in the ILUA areas. It is recommended a NSHA is entered into, and an 'Activity Notice' issued under the NSHA, if there is a risk that an activity will 'impact' (i.e. by excavating, damaging, destroying or altering in any way) an Aboriginal heritage site. The Aboriginal Heritage Due Diligence Guidelines, which are referenced by the NSHA, provide guidance on how to assess the potential risk to Aboriginal heritage.

Likewise, from 8 June 2015 the Department of Mines, Industry Regulation and Safety (DMIRS) in granting Mineral, Petroleum and related Access Authority tenures within the South West Settlement ILUA areas, will place a condition on these tenures requiring a heritage agreement or a NSHA before any rights can be exercised.

If you are a State Government Department, Agency or Instrumentality, or have a heritage condition placed on your mineral or petroleum title by DMIRS, you should seek advice as to the requirement to use the NSHA for your proposed activity. The full ILUA documents, maps of the ILUA areas and the NSHA template can be found at https://www.wa.gov.au/organisation/department-of-the-premier-and-cabinet/south-west-native-title-settlement.

Further advice can also be sought from the Department of Planning, Lands and Heritage at AboriginalHeritage@dplh.wa.gov.au.

Copyright

Coordinate Accuracy

Coordinates (Easting/Northing metres) are based on the GDA 94 Datum. Accuracy is shown as a code in brackets following the coordinates.

Terminology (NB that some terminology has varied over the life of the legislation)

Place ID/Site ID: This a unique ID assigned by the Department of Planning, Lands and Heritage to the place.

Status:

- Registered Site: The place has been assessed as meeting Section 5 of the *Aboriginal Heritage Act 1972.*
- Other Heritage Place which includes:
  - Stored Data / Not a Site: The place has been assessed as not meeting Section 5 of the *Aboriginal Heritage Act 1972.*
  - Lodged: Information has been received in relation to the place, but an assessment has not been completed at this *stage* to determine if it meets Section 5 of the *Aboriginal Heritage Act 1972.*

Access and Restrictions:

- File Restricted = No: Availability of information that the Department of Planning, Lands and Heritage holds in relation to the place is not restricted in any way.
- File Restricted = Yes: Some of the information that the Department of Planning, Lands and Heritage holds in relation to the place is restricted if it is considered culturally sensitive. This information will only be made available if the Department of Planning, Lands and Heritage receives written approval from the informants who provided the information. To request access please contact AboriginalHeritage@dplh.wa.gov.au.
- Boundary Restricted = No: Place location is shown as accurately as the information lodged with the Registrar allows.
- Boundary Restricted = Yes: To preserve confidentiality the exact location and extent of the place is not displayed on the map. However, the shaded region (generally with an area of at least 4km²) provides a general indication of where the place is located. If you are a landowner and wish to find out more about the exact location of the place, please contact the Department of Planning, Lands and Heritage.
- Restrictions:
  - No Restrictions: *Anyone* can view the information.
  - Male Access Only: Only *males* can view restricted information.
  - Female Access Only: *Only* females can view restricted information.

Legacy ID: This is the former unique number that the former Department of Aboriginal Sites assigned to the place. This has been replaced by the Place ID / Site ID.

Aboriginal Heritage Inquiry System

List of Registered Aboriginal Sites

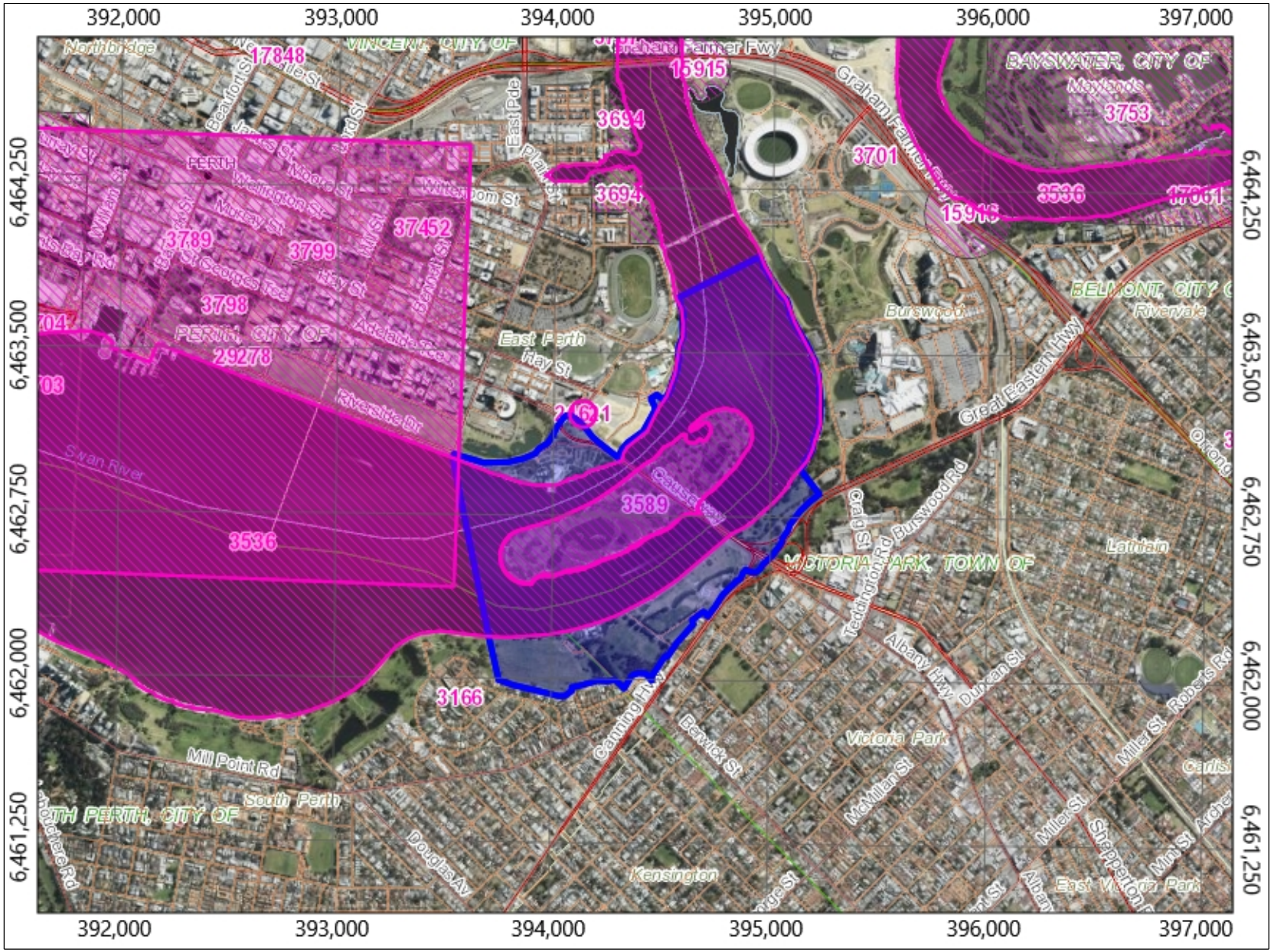
ID	Name	File Restricted	Boundary Restricted	Restrictions	Status	Type	Knowledge Holders	Coordinate	Legacy ID
3536	SWAN RIVER	No	No	No Gender Restrictions	Registered Site	Mythological	*Registered Knowledge Holder names available from DAA	395287mE 6456166mN Zone 50 [Reliable]	S02548
3589	HEIRISSON ISLAND.	No	No	No Gender Restrictions	Registered Site	Mythological, Camp, Hunting Place, Meeting Place, Plant Resource	*Registered Knowledge Holder names available from DAA	394357mE 6462806mN Zone 50 [Reliable]	S02415
21621	Kilang Minangaldjkba	No	No	No Gender Restrictions	Registered Site	Water Source	*Registered Knowledge Holder names available from DAA	394127mE 6463219mN Zone 50 [Reliable]	
29278	Midgegooroo's Execution and Burial	Yes	Yes	Male Access Only	Registered Site	Historical, Skeletal Material / Burial	*Registered Knowledge Holder names available from DAA	Not available when location is restricted	

Department of Planning, Lands and Heritage

Aboriginal Heritage Inquiry System

Map of Registered Aboriginal Sites

For further important information on using this information please see the Department of Planning, Lands and Heritage's Disclaimer statement at https://www.dplh.wa.gov.au/about-this-website



Legend

- Registered Aboriginal Site
- Search Area
- Town
- Road
- River
- Local Government Authority

1.03 kilometres

Map Scale 1 : 31,300

MGA Zone 50 (GDA94)

Aboriginal Heritage Inquiry System

List of Other Heritage Places

Search Criteria

1 Other Heritage Places in Shapefile - Heritage_Survey_Area30092020

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Aboriginal Heritage Inquiry System

List of Other Heritage Places

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36738	SWAN RIVER 1	No	No		Stored Data / Not a Site	Mythological	*Registered Knowledge Holder names available from DAA	394470mE 6463231mN Zone 50 [Reliable]	

Department of Planning, Lands and Heritage

Aboriginal Heritage Inquiry System

Map of Other Heritage Places

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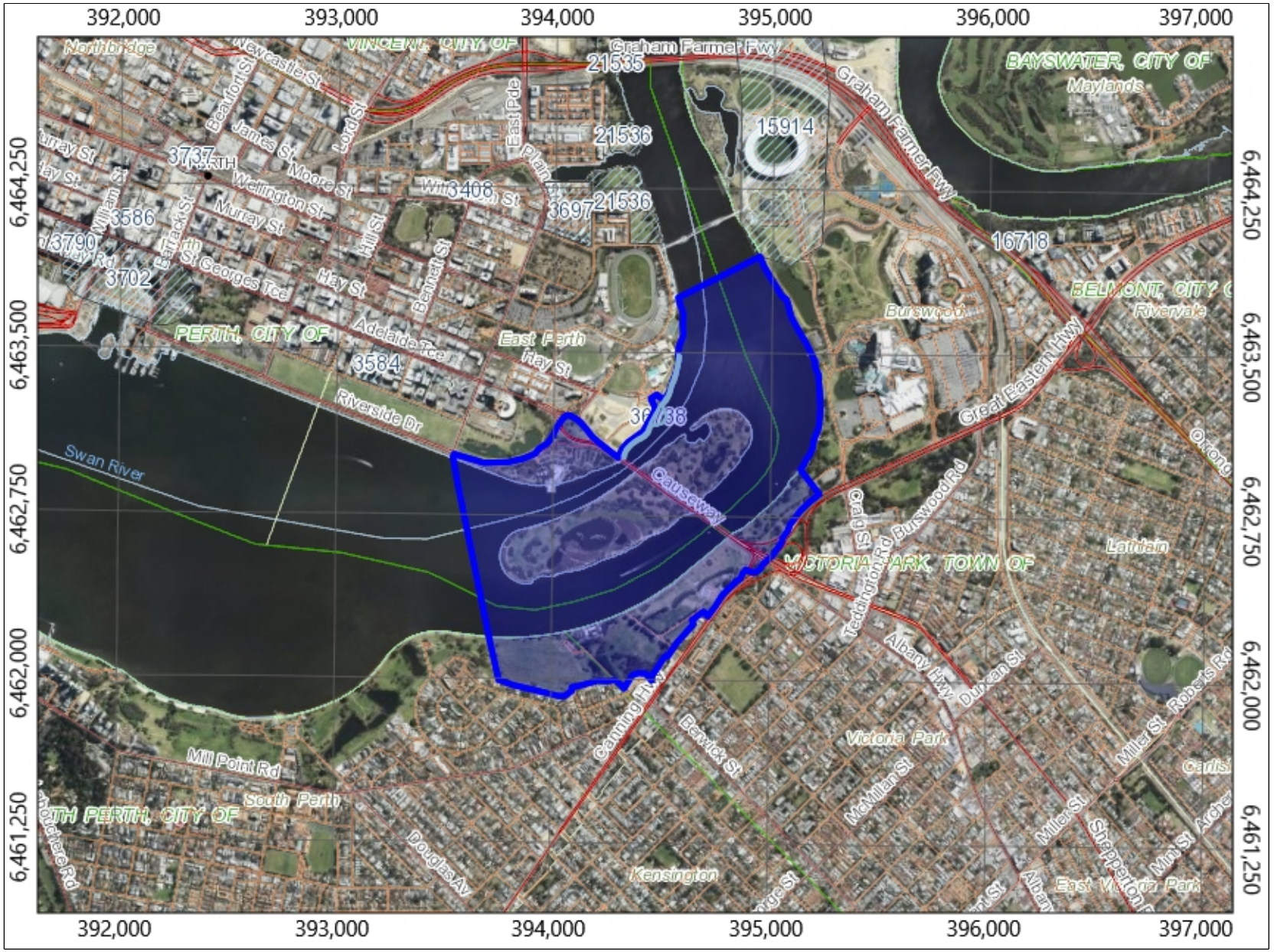

Legend

- Other Heritage Place
- Search Area
- Town
- Road
- River
- Local Government Authority

1.03 kilometres

Map Scale 1 : 31,300

MGA Zone 50 (GDA94)

Aboriginal Heritage Inquiry System

List of Heritage Surveys

Search Criteria

31 Heritage Surveys containing 31 Survey Areas in Shapefile - Heritage_Survey_Area30092020

Disclaimer

Heritage Surveys have been mapped using information from the reports and / or other relevant data sources. Heritage Surveys consisting of small discrete areas may not be visible except at large scales. Reports shown may not be held at the Department of Planning, Lands and Heritage (DPLH). Please consult report holder for more information. Refer to www.dplh.wa.gov.au/information-and-services/aboriginal-heritage for information on requesting reports held by DPLH.

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Further advice can also be sought from the Department of Planning, Lands and Heritage at AboriginalHeritage@dplh.wa.gov.au.

Copyright

Access

Some reports are restricted.

Spatial Accuracy

The following legend strictly applies to the spatial accuracy of heritage survey boundaries as captured by DPLH.

Very Good	Boundaries captured from surveyed titles, GPS (2001 onwards) submitted maps georeferenced to within 20m accuracy.
Good / Moderate	Boundaries captured from GPS (pre 2001) submitted maps georeferenced to within 250m accuracy.
Unreliable	Boundaries captured from submitted maps georeferenced to an accuracy exceeding 250m.
Indeterminate	Surveys submitted with insufficient information to allow boundary capture.

Basemap Copyright

Aboriginal Heritage Inquiry System

List of Heritage Surveys

Survey Report ID	Report Title	Report Authors	Area Number	Survey Type	Area Description	Spatial Accuracy	Field / Desktop
19225	Report on a heritage survey of proposed developments for the upgrade of the City Foreshore, Perth WA	Fisher, Stuart	1	Archaeological & Ethnographic	Proposed developments for the upgrade of the City Foreshore, Perth. The development of four distinct nodes totalling approximately 352000 sq.m as shown in Maps. 3-6	Very Good	Field and Desktop
19233	Installation of a fibre-optic cable under the Swan River and Heirisson Island at the Causeway & Under the Canning River at Canning Bridge	Parker, Susan	1	Archaeological & Ethnographic	The Causeway & Canning Bridges.	Good	Field and Desktop
20145	Site avoidance survey under the Aboriginal Heritage Act (1972) of proposed commercial and residential redevelopment project at East Perth, Western Australia	Parker, Susan	1	Ethnographic	Proposed Commercial and Residential Redevelopment Project at East Perth. Eastern Gateway Precinct, an area of 40ha as shown in Map 3.	Very Good	Field and Desktop
21088	A Socio-economic Anthropological Survey of People of Aboriginal Descent in the Metropolitan Region of Perth, Western Australia	Makin, C F	1	Ethnographic	Metropolitan Region of Perth as shown in Figs. 1 and 2.	Very Good	Field and Desktop
21291	Aboriginal Heritag issues associated with the Eastern Gateway Precinct Redevelopment, East Perth, Western Australia	Murphy, A.	1	Archaeological & Ethnographic	Eastern Gateway Precinct Redevelopment, East Perth. An area of 40ha roughly bounded by the Causeway/Adelaide Terrace to the south; the Swan River to the east and already redeveloped parts of East Perth to the north and west as shown in Figure 1	Very Good	Field and Desktop
21817	Ballaruk (traditional owners) Aboriginal site recording project	Machin, Barrie	1	Ethnographic	Whadjuk territorial boundaries the lands of the Ballaruk Peoples as shown in Figure 10.	Unreliable	Field and Desktop
21818	Ballaruk (traditional owners of Whadjuk territorial boundaries the lands of the Ballaruk Peoples) Aboriginal site recording project : additional material	Machin, Barrie	1	Ethnographic	Whadjuk territorial boundaries the lands of the Ballaruk Peoples as shown in Figure 10.	Unreliable	Field and Desktop
21909	Study of groundwater - related Aboriginal Cultural Values on the Gnangara Mound, Western Australia	McDonald Edward	1	Ethnographic	The Gnangara Mound area as shown in Figure 2 of the Fisher report attached as appendix 3 to the Estill report.	Very Good	Field and Desktop
21910	Study of groundwater - related Aboriginal Cultural Values on the Gnangara Mound, Western Australia : Volume 1 restricted report	McDonald Edward	1	Archaeological & Ethnographic	Study of groundwater - related Aboriginal Cultural Values on the Gnangara Mound, Western Australia : Volume 1 restricted report	Moderate	Field and Desktop

Survey Report ID	Report Title	Report Authors	Area Number	Survey Type	Area Description	Spatial Accuracy	Field / Desktop
21911	Study of groundwater - related Aboriginal Cultural Values on the Gnangara Mound, Western Australia : Volume 2 inventory of registered sites restricted report for Department of Environment	McDonald Edward	1	Archaeological & Ethnographic	Study of groundwater - related Aboriginal Cultural Values on the Gnangara Mound	Moderate	Field and Desktop
22089	City of South Perth : South Perth foreshore management masterplan - Section 18 notice.	M P Rogers & Associates	1	Archaeological & Ethnographic	South Perth foreshore	Moderate	Field and Desktop
22113	Report on an Aboriginal heritage survey of the proposed DN600 pressure main replacement in McCallum Park.	R & E O'Connor Pty Ltd	1	Ethnographic	McCallum Park, Claisebrook, Western Australia	Good	Field and Desktop
22114	Report on a preliminary archaeological investigation for Aboriginal sites McCallum Park mains replacement DN600 Horden - Claisebrook PM metropolitan wastewater system.	Quartermaine, Gary.	1	Archaeological	McCallum Park, Claisebrook, Western Australia	Good	Field and Desktop
22661	The report of an Indigenous ethnographic assessment of a proposal to replace wastewater pressure mains between Victoria Park No. 1 (Hordern Street) pumping station and Claisebrook pumping station, East Perth.	Gifford, Peter ; Draper, Neale	1	Archaeological & Ethnographic	Pipeline from Hordern Street pumping station to Claisebrook pumping station, East Perth	Very Good	Field and Desktop
22776	Report on an Aboriginal heritage survey of the proposed Good Vibrations Festival and its associated works, Heirisson Island, City of Perth WA	Dortch, Joe	1	Archaeological & Ethnographic	The survey area occupies approximately 7.5 hectares of land at the northern half of Herisson Island in the City of Perth LGA.	Good	Field and Desktop
22875	Report on An Ethnographic Aboriginal Heritage Survey of The Proposed Developments at McCollum Park / Taylor Reserve, Town Of Victoria Park, WA	Fisher, Stuart	1	Ethnographic	The survey area is located in the Town of Victoria Park on the foreshore of the Swan River. It is bounded by The Causeway to the north, Taylor Street to the south, Canning Highway to the east and the Swan River to the west.	Good	Field and Desktop
23056	Enrich Walk Trail Master Plan	Estill & Associates	1	Archaeological & Ethnographic	Perth City	Moderate	Field and Desktop
23057	Indigenous interpretive trail for the City of Perth foreshore ; concept plan	Baxter, Maggie	1	Archaeological & Ethnographic	Indigenous interpretive trail for the City of Perth foreshore ; concept plan	Moderate	Field and Desktop
23058	Enrich Walk Trail Perth, Western Australia : consultation plan	Syrinx Environmental PL	1	Archaeological & Ethnographic	Enrich Walk Trail Perth, Western Australia : consultation plan	Moderate	Field and Desktop

Aboriginal Heritage Inquiry System

List of Heritage Surveys

Survey Report ID	Report Title	Report Authors	Area Number	Survey Type	Area Description	Spatial Accuracy	Field / Desktop
23129	Report on an Aboriginal heritage survey of the proposed Waterbank development at lot 500 Hay Street Perth WA	Fisher, Stuart	1	Archaeological & Ethnographic	The survey area is located on Lot 500 on deposited plan 54248 in the City of Perth LGA.	Very Good	Field and Desktop
23168	Aboriginal Heritage Protection : Addendum to the Report on an Aboriginal Heritage Survey of the Proposed Good Vibrations Festival and its Associated Works, Heirisson Island, City Of Perth WA	Fisher, Stuart	1	Archaeological & Ethnographic	Heirisson Island, Perth.	Very Good	Field and Desktop
23181	Supplementary Aboriginal Heritage Consultation Report to the ACMC for Swan Valley Nyungah Community People and Jam Music - Good Vibrations Festival Heirisson	Wright, Guy.	1	Ethnographic	A small portion of land on the south side of the Causeway needed for channelling people through an underpass in order to assist the crowd control of the Good Vibrations Festival, otherwise the Festival will take place on the north side of the Causeway.	Good	Field only
23581	Addendum to a Report on a Desktop Study of Aboriginal Heritage Issues Relating to the South Perth Foreshore Management Plan : An Ethnographic Consultsation	Australian Interaction Consultants ; O'Connor, R & E ; Quartermaine Consultants	1	Archaeological & Ethnographic	Swan and Canning Rivers between South Perth and Wilson, including Bridges 912 and 913 on Canning Highway, between Applecross and Como	Good	Field and Desktop
23859	An Aboriginal Heritage Survey of the Heirisson Island Sculpture Park, Perth Western Australia	Goode, Brad ; Chown, Bob ; Harris, Jacqueline	1	Archaeological & Ethnographic	Heirrisson Island, Perth	Very Good	Field and Desktop
102597	A Survey for Aboriginal Sites - Ethnographic Investigations Relating to some Proposed Highway & Road Developments in the Perth Metropolitan Area.	Brown, S H	1	Ethnographic	Proposed Highway and Road Developments in the Perth Metropolita Area. Projects covered in this report are: 1) Beechboro-Gosnells Highway. Guildford Road to Morley Drive. 2) Beechboro-Gosnells Highway. Great Eastern Highway to Guildfor Road. 3) Beechboro-Gosnells Highway. Leach Higway to Great Eastern Highway. 4) Beechboro-Gosnells Highway. Newburn Road to Roe Highway (Forrestfield Railway Bridges). Beechboro-Gosnells Highway. Maida Vale Road Relocation.. 6) Guildford Road Bridge Duplicatio...	Unreliable	Field and Desktop
102670	Preliminary Report on the Survey of Aboriginal Areas of Significance in the Perth Metropolitan & Murray River Regions July 1985.	O'Connor, R	1	Ethnographic	Perth Metropolitan & Murray River Regions. A roughly triangular region, with Yanchep National Park as the Northern point, Gidgegannup as the Eastern point and Pinjarra as the Southern point.	Indeterminate	Field and Desktop
103014	Addendum to Aboriginal site survey of Dampier to Perth natural gas pipeline - gas lateral facilities Carnarvon lateral	Quartermaine G	1	Archaeological & Ethnographic	The survey area consists of two major realignments of the Carnarvon Lateral Gas Pipeline route and some minor realignments, on the DPNGP. Heritage sites 8891, 8892 &8893 were identified during the survey.	Unreliable	Field and Desktop

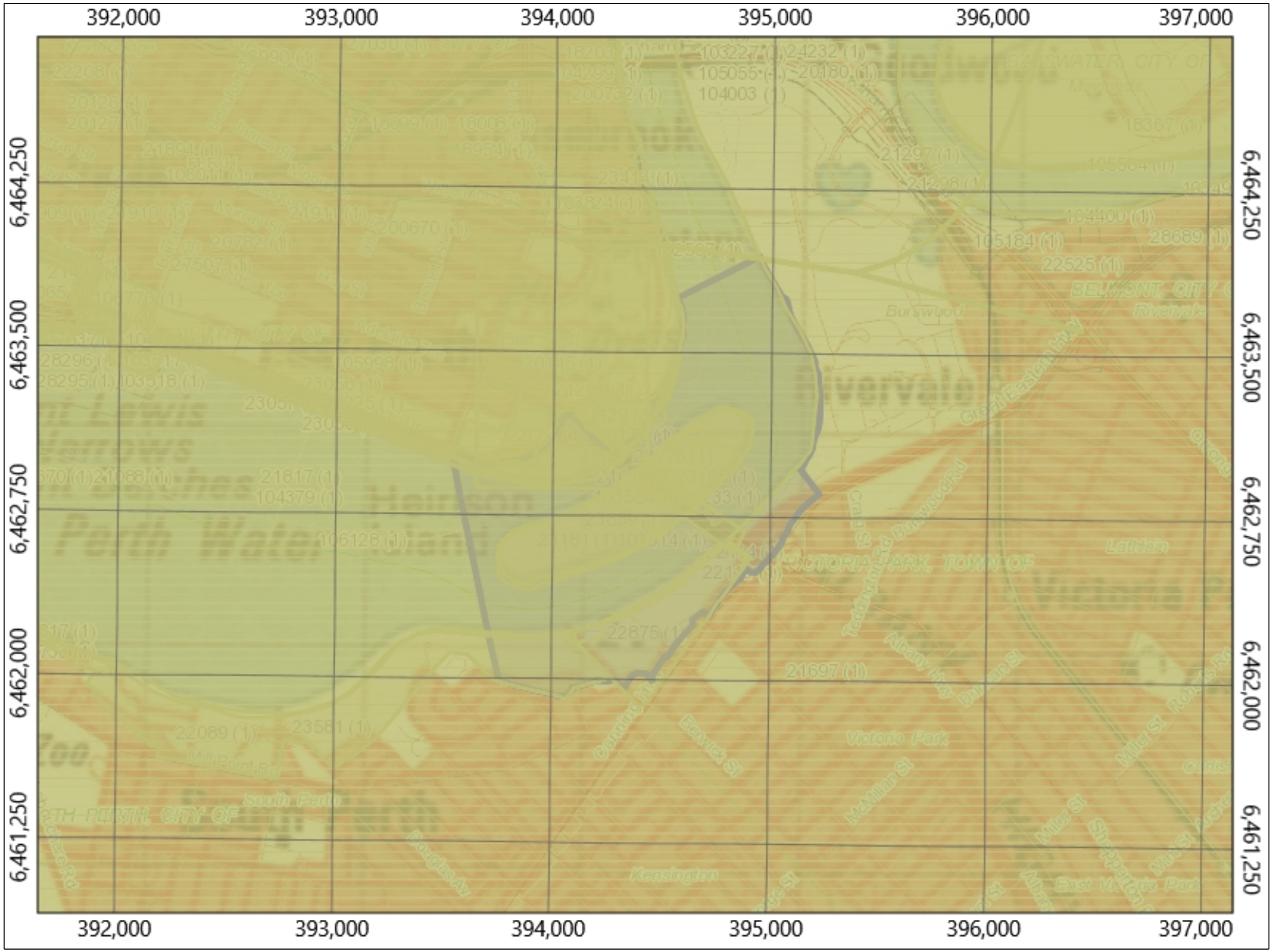
Survey Report ID	Report Title	Report Authors	Area Number	Survey Type	Area Description	Spatial Accuracy	Field / Desktop
103564	An Archaeological Survey Project: The Perth Area, Western Australia. Apr 1972.	University of Western Australia.	1	Archaeological	The Perth Area. 103 site locations in 67 site groups were investigated.	Indeterminate	Field and Desktop
104379	Australian Research Grants Scheme: Final Report on the Project the Swan Coastal Plain, Western Australia.	Hallam, S.	1	Archaeological	The survey area comprises 396 DIA sites/heritage locations listed in Appendix, and distributed throughout the Coastal Plain and Darling Ranges and Darling Plateau, from Lancelin south past Mandurah, as shown in Figure 1. The survey area location and extent are as per the AHMS.	Unreliable	Field and Desktop
106128	Metropolitan sites project northern metro area	Corsini, Stephen John	1	Archaeological	Metropolitan Sites Project - Northern Metro Area. The areas surveyed are those sites in the City of Mosman and Joondalup as shown in Tables 1 and 2	Unreliable	Field and Desktop
200172	Outcomes of Consultations with Metropolitan Area Nyoongar Groups for the Waterbank Development, East Perth	O'Neill, Teri ; de Garis, Bonjana	1	Archaeological & Ethnographic	Outcomes of Consultations with Metropolitan Area Nyoongar Groups for the Waterbank Development, East Perth : November 2014 [TBD]	Good	Field and Desktop

Department of Planning, Lands and Heritage

Aboriginal Heritage Inquiry System

Map of Heritage Survey Areas

For further important information on using this information please see the Department of Planning, Lands and Heritage's Disclaimer statement at https://www.dplh.wa.gov.au/about-this-website



Legend

- Heritage Survey Area
- Search Area
- Town
- Road
- River
- Local Government Authority

1.03 kilometres

Map Scale 1 : 31,300

MGA Zone 50 (GDA94)

Appendix C: Aboriginal Heritage Risk Assessment

AHRA - D21#215094

Aboriginal Heritage Risk Assessment (AHRA) Form

The purpose of the Aboriginal Heritage Risk Assessment (AHRA) form is to identify the risk a project has on impacting Aboriginal heritage sites as defined by the *Aboriginal Heritage Act 1972* (AHA). The risk assessment is based on the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Due Diligence Guidelines (version 3.0, 30 April 2013). Please refer to the Aboriginal Heritage Guideline for further information. The AHRA also forms part of the Main Roads corporate Environmental Assessment, Approval and Compliance Process. Environment Officers are required to complete all items of the AHRA and Project Managers are required to acknowledge and sign the form. The completed form must be submitted to Environment Branch (at LISCandAHRA@mainroads.wa.gov.au) for review by Main Roads' Principal Heritage Officer (PHO) or Heritage Officer (HO). Text in red italics are guidance notes.

PROJECT DETAILS	
Project Name:	Causeway Pedestrian and Cyclist Bridge (CPCB) Project
Region/Directorate:	PTS / IDD
Expected Project Start Date:	2022
Road Name & No.:	Adjacent to the Causeway (H726; bridges 0932 & 0914)
Project Location (SLK):	NA
TRIM No.:	20/6200
TRIM Link to Spatial Data:	D21#190779
EOS No.:	2204
Project No. & Task Code:	21117040 / 19301
SCOPE OF THE PROJECT	
Project Description:	The Causeway Pedestrian and Cyclist Bridge (CPCB) project involves the provision of a new active transport river crossing linking East Perth to Victoria Park via Heirisson Island. Comprising of two cable stay bridges, the proposed crossing will be located approximately 80-100m downstream of the existing Causeway traffic bridges. The design and alignment were chosen after an extensive stakeholder consultation and options assessment process managed by the Department of Transport in 2019. In August 2020 the State Government announced funding towards the construction of the bridge which was to be further developed and constructed by MRWA. The scope of the project includes: - Two cable stayed bridges with 2 piers in the McCallum Park bridge and 1 pier in the Point Fraser bridge. - 6.0 m wide separated path - Bridge design is acknowledgement of Aboriginal history and culture. - Increased navigational clearances for both structures in particular the Point Fraser structure i.e. the primary river navigational channel. - Bridge alignment to minimise the impacts to trees on McCallum Park, Point Fraser and Heirisson Island. - Bridge material proposed is weathering steel but is subject to further investigation. Modifications to the existing traffic bridges is not included in the scope of works.
Machinery to be used:	Drilling barge, large excavators, barge mounted crane etc.
Will water be needed for the project:	TBC
What ground disturbing activities will be undertaken:	Geotechnical investigations prior to construction including boreholes, cone penetrometer tests and test pits. Construction of bridge embankment,abutments/approaches and support piers on Heirisson Island, McCallum Park and Pt Fraser; dredging and construction of pylons in the Swan River. Installation of temporary piers in the river to facilitate construction of the bridge.

ABORIGINAL HERITAGE INQUIRY SYSTEM (AHIS) SEARCH[1]	
Which search did you use:	☐ Co-ordinates ☒ Shapefile ☐ Custom Area
How much of a buffer did you include:	0
No. of Registered Sites in search area:	4 ("Swan River" ID 3536, "Heirisson Island" ID 3589, "Kilang Minangaldjkba" ID 21621 and "Midgegooroo's Execution and Burial" ID 29278)
No. of Lodged sites in search area:	0
No. of Insufficient/ Stored Data sites in search area:	1 ("Swan River 1" ID 36738)
Is the entire project area covered by existing surveys?	☒ Yes ☐ No
If yes, what are the survey(s) type:	☒ Ethnographic ☒ Archaeological
Provide any additional information:	AHIS Registered Site Search Results at D21#214972 AHIS Other Heritage Site Search Results at D21#214975 AHIS Survey Search Results at D21#214977

POTENTIAL TO AVOID HERITAGE SITES

If the project is going to impact on a heritage place or site, could the footprint of project be altered to avoid negative impacts?

☐ Yes ☒ No ☐ Unsure ☐ N/A

Comments: The Causeway Pedestrian and Cyclist Bridge crosses both the Swan River (Site 3536) and Heirisson Island (Site 3589). Regardless of the final location, avoidance of these sites is not necessary. Aboriginal consultation was undertaken by the Department of Transport in the planning of the project which identified the proposed location as the preferred alignment which least impacts the more sensitive sites of the island (i.e. upstream section of the island).

PREVIOUS LAND USE *(select which best describes the project impact)*

Categories	Description	Select X
Built Environment	Urban land use, towns, metropolitan region	☐
Significantly Altered Environment	Cultivated and cleared land, farmland; rehabilitated landscape	☒
Moderately Altered Environment	Partially cleared lands, revegetated landscape	☐
Minimally Altered Environment	Urban bushland, regrowth areas, slightly disturbed natural bushland	☐
Unaltered Environment	Protected areas or pristine environment	☐

LIKELY LAND IMPACT OR DISTURBANCE FROM ACTIVITY *(select the most appropriate level)*

Categories	Description	Select X
NEGLIGIBLE	**Activities which are non-invasive and cause negligible or no impact to the land may include:** • walking, photography, filming for assessing project scope, vegetation and heritage • magnetic surveys • use of existing tracks, water courses	☐

[1]AHIS Search is available at https://maps.daa.wa.gov.au/ahis/. Main Roads should exercise caution in areas where no surveys have been completed, or where surveys have only been completed for parts of the area where the proposed activity is intended. Heritage surveys that cover only part of the land may not have identified all possible sites. Sole reliance on information contained in the AHIS Register may not be sufficient and consultation in the first instance with a Heritage Officer is recommended in these situations.

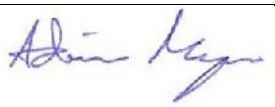
	• environmental monitoring • water and soils sampling using hand held instruments • fossicking using hand held instruments • spatial measurement • scientific research, using hand held tools	
MINIMAL	**Activities that cause minimal disturbance to the land may include:** • cultivation/grazing in areas previously cultivated/grazed • maintenance of existing paths, walls, roads, tracks, bridges, public infrastructure and community utilities within the existing footprint and adjacent service areas • feral animal eradication, weed, vermin and pest control, vegetation control and fire control • light vehicular access and camping	☐
MODERATE	**Activities that cause moderate disturbance to the land may include:** • maintenance of bridges that disturb river bed and/or banks • sampling using hand held rig or rig mounted on a light vehicle • new fire breaks • road widening within existing corridor • re-vegetation • temporary power lines, material stockpiles, camps • surface vegetation clearing	☐
SIGNIFICANT	**Activities that cause significant disturbance to the land may include:** • creation of new roads, borrow pits or tracks • new public access ways, bridges, culverts, flood remediation and erosion levies • intensive soil/core sampling • new pipelines • significant reclamation works • major landscaping/contouring	☐
MAJOR	**Activities that cause major and lasting disturbance to the land may include:** • large-scale land clearing • material extraction • mechanical earthmoving, blasting • major construction works • large scale changes to waterways	☒

	ABORIGINAL HERITAGE RISK MATRIX					
		LIKELY IMPACT ON HERITAGE SITES				
PREVIOUS LAND USE	**Built Environment**	**Negligible**	**Minimal**	**Moderate**	**Significant**	**Major**
	Significantly Altered	Low	Low	Low	Low	Medium
	Moderately Altered	Low	Low	Low	Medium	High
	Minimally Altered	Low	Low	Medium	Medium	High
	Unaltered	Low	Medium	Medium	High	High
		Low	Medium	High	High	High
RISK RATING						
High						

RISK RATING	**POTENTIAL ACTIONS**
LOW	**Consult with a Heritage Officer, if uncertain how to proceed. A range of further actions may be required, including:** • Consult the DPLH • Desktop survey • Aboriginal consultation
MEDIUM Review & Exercise Caution	**Consult with a Heritage Officer and a range of further actions may be required, including:** • Consult the DPLH

	• Desktop survey • Aboriginal consultation • Ethnographic survey • Archaeological survey
HIGH Consult; Survey; Approvals	**Consult with a Heritage Officer, and a range of further actions may be required, including:** • Desktop survey • Consult the DPLH • Aboriginal consultation • Ethnographic survey • Archaeological survey • Application for Section 18 of the AHA approval • Application for Regulation 7 or 10 of the AHR approval • Cultural Heritage Management Plan (CHMP)

HERITAGE AGREEMENT & ACTIVITY NOTICE CHECKLIST	
Is the project within an area Main Roads has a Heritage Agreement (HA) over? *e.g. Noongar Standard HA (NSHA), Esperance Nyungar Government Standard HA, Thalanyji HA*	Yes ☒ No ☐ Unsure ☐
If yes, which Native Title Group is the HA with? *e.g. Whadjuk, Thalanyji, Yawuru*	Whadjuk

SIGNATURES		
	Project Manager	**Environment Officer**
Name	**Adrian Minogue**	**Fiona van Rijnswoud**
Signature		*F. van Rijnswoud*
Job Title	**Project Manager Development**	**Environment Officer**
Date	**26/02/21**	**25/02/2021**

HERITAGE OFFICER REVIEW

Further Actions Required

☐	**None**	☐	**Aboriginal Consultation**	☐	**Consult with DPLH**
☐	**Desktop Study**	☐	**Ethnographic Survey**	☐	**Archaeological Survey**
☐	**Reg. 10 Approval**	☐	**s18 Approval**	☐	**Activity Notice**
☐	**Cultural Heritage Management Plan (CHMP)**			☐	**Other**

Heritage Officer's Review Comments

S18 Aboriginal heritage survey to be undertaken with the Whadjuk Noongar People, requiring an Activity Notice to be sent to SWALSC. Regulation 7 & 10 application to be submitted (post consultation) for the geotech.

Heritage Office to be consulted regarding historic bridge material in the area of the works.

Reviewed by Heritage Officer

Name	**Sandra Barkla**
Signature	*Sandra Barkla*
Job Title	**Principal Heritage Officer**

Date	4/03/2021

Legend

- State Road
- Local Road
- PER.01_Heirisson_Island_bicyclebridge_PD_v09
- Heritage_Survey_Area

Figure 1 Causeway Pedestrian & Cyclist Bridge Aboriginal Heritage Risk Assessment (AHRA)

mainroads WESTERN AUSTRALIA

Appendix D: Site Photos

Image 1. Looking west from the middle of the project area on Point Fraser foreshore. Photo shows planted *Casuarina obesa* and *Juncus kraussii* that occur as a narrow strip of vegetation between the Swan River to the south and a footpath to the north.

Image 2. Looking east from the middle of the project area on Point Fraser foreshore. Photo shows *Casuarina obesa* and *Juncus kraussii* that were planted on the shoreline.

Image 3. Looking south-east in the project area on Point Fraser foreshore. Photo shows planted *Casuarina obesa* and *Atriplex prostrata* fringing the shoreline.

Image 4. Looking south-west in the project area on Point Fraser foreshore. Photo shows planted *Casuarina obesa* and *Scaevola crassifolia* along the shoreline and next to the footpath.

Image 5. Looking north and showing mixed planted native vegetation within the project area on Point Fraser. This vegetation borders Riverside Drive on the northern edge and a PSP on the southern side.

Image 6. Looking west and showing mixed planted native vegetation within the south-western section of the project area on Point Fraser.

Image 7. Looking south-west towards the western boundary of the project area. Photo shows mixed planted native vegetation occurring as patches over lawns on Point Fraser.

Image 8. Looking south-west towards the western boundary of the project area. Photo shows mixed planted native vegetation bordering a lawned area on Point Fraser.

Image 9. Looking south-east and showing a section of the project area on Heirisson Island. Photo shows isolated individuals of *Melaleuca lanceolata* and *Casuarina obesa* that will be cleared for the project.

Image 10. Looking south-west and showing a section of the project area on Heirisson Island. Photo shows the isolated individuals of *Melaleuca lanceolata* and *Casuarina obesa* that will be cleared for the project.

Appendix E: DAWE Protected Matters Database Search

PMST Report - D21#1208564

Australian Government

Department of Agriculture, Water and the Environment

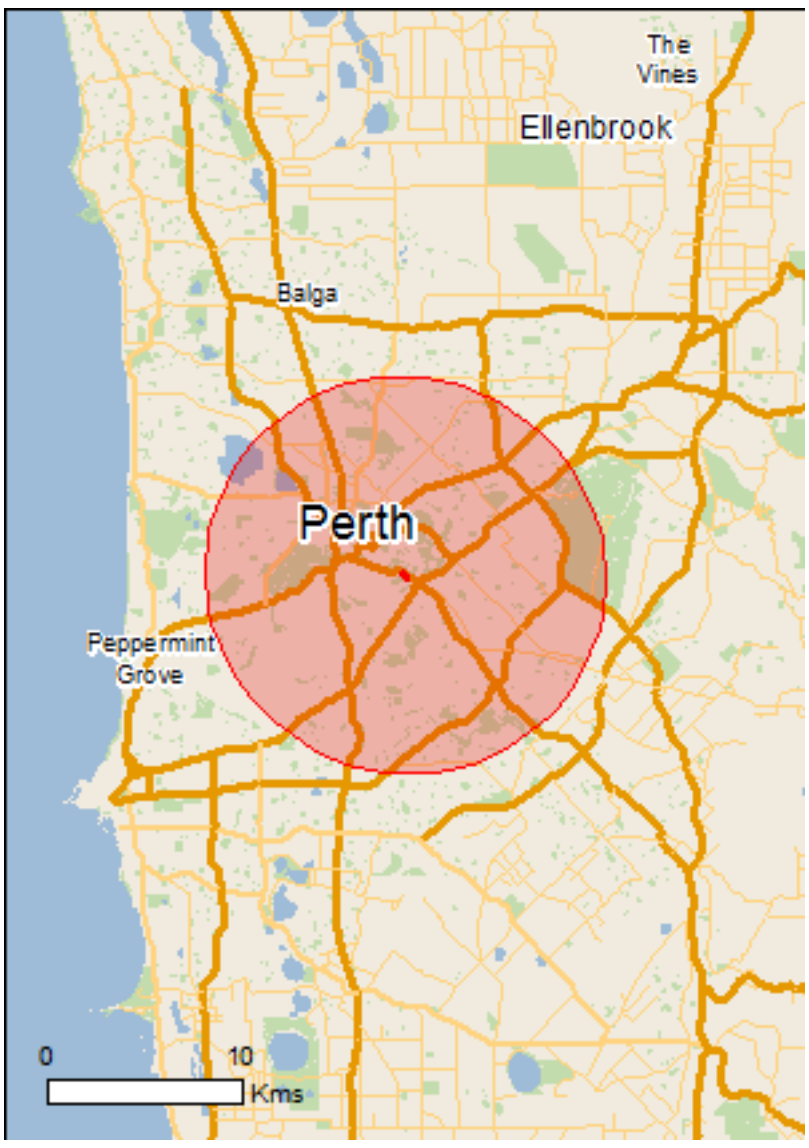
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

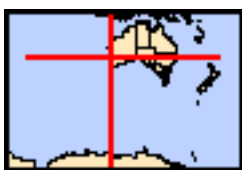
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 24/11/21 13:42:54



Coordinates

Buffer: 10.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	5
Listed Threatened Species:	58
Listed Migratory Species:	49

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	5
Commonwealth Heritage Places:	5
Listed Marine Species:	56
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	16
Regional Forest Agreements:	None
Invasive Species:	43
Nationally Important Wetlands:	5
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Forrestdale and thomsons lakes	Within 10km of Ramsar

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	Community likely to occur within area
Clay Pans of the Swan Coastal Plain	Critically Endangered	Community likely to occur within area
Corymbia calophylla - Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Endangered	Community known to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area

Name	Status	Type of Presence
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Critically Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Insects		
Hesperocolletes douglasi Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
Leioproctus douglasiellus a short-tongued bee [66756]	Critically Endangered	Species or species habitat known to occur within area

Name	Status	Type of Presence
Mammals		
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area
Pseudocheirus occidentalis Western Ringtail Possum, Ngwayir, Womp, Woder, Ngoor, Ngoolangit [25911]	Critically Endangered	Species or species habitat likely to occur within area
Other		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat may occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat known to occur within area
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat may occur within area
Austrostipa bronwenae [87808]	Endangered	Species or species habitat may occur within area
Banksia mimica Summer Honeypot [82765]	Endangered	Species or species habitat likely to occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat likely to occur within area
Calytrix breviseta subsp. breviseta Swamp Starflower [23879]	Endangered	Species or species habitat likely to occur within area
Chamelaucium sp. Gingin (N.G.Marchant 6) Gingin Wax [88881]	Endangered	Species or species habitat may occur within area
Conospermum undulatum Wavy-leaved Smokebush [24435]	Vulnerable	Species or species habitat likely to occur within area
Diplolaena andrewsii [6601]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat likely to occur within area
Diuris micrantha Dwarf Bee-orchid [55082]	Vulnerable	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat likely to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved	Endangered	Species or species

Name	Status	Type of Presence
Hammer Orchid, Warty Hammer Orchid [16753]		habitat likely to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat likely to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat likely to occur within area
Eremophila glabra subsp. chlorella [84927]	Endangered	Species or species habitat known to occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat may occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat likely to occur within area
Grevillea thelemanniana Spider Net Grevillea [32835]	Critically Endangered	Species or species habitat known to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat may occur within area
Macarthuria keigheryi Keighery's Macarthuria [64930]	Endangered	Species or species habitat likely to occur within area
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area
Migratory Marine Species		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Manta alfredi Reef Manta Ray, Coastal Manta Ray, Inshore Manta Ray, Prince Alfred's Ray, Resident Manta Ray [84994]		Species or species habitat may occur within area
Manta birostris Giant Manta Ray, Chevron Manta Ray, Pacific Manta Ray, Pelagic Manta Ray, Oceanic Manta Ray [84995]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Name	Threatened	Type of Presence
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area

Name	Threatened	Type of Presence
Pluvialis fulva		
Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola		
Grey Plover [865]		Roosting known to occur within area
Tringa brevipes		
Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola		
Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus		
Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Defence - AIRTC CANNINGTON
Defence - HOLDFAST BARRACKS
Defence - IRWIN BARRACKS - KARRAKATTA
Defence - SWAN BARRACKS

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Army Magazine Buildings Irwin Barracks	WA	Listed place
Inglewood Post Office	WA	Listed place
Perth General Post Office	WA	Listed place
South Perth Post Office	WA	Listed place
Victoria Park Post Office	WA	Listed place

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Species or species habitat likely to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat likely to occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Thinornis rubricollis		
Hooded Plover [59510]		Species or species habitat known to occur within area
Tringa glareola		
Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Tringa totanus		
Common Redshank, Redshank [835]		Roosting known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]		Roosting known to occur within area
Mammals		
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area
Reptiles		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Alfred Cove	WA
Canning River	WA
Kings Park	WA
Matilda Bay Reserve	WA
Milyu	WA
Perth Zoo	WA
Swan River	WA
Unnamed WA31906	WA
Unnamed WA36440	WA
Unnamed WA44414	WA
Unnamed WA45772	WA
Unnamed WA45773	WA
Unnamed WA49362	WA
Unnamed WA49363	WA

Name	State
Unnamed WA50067	WA
Unnamed WA52237	WA

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus aethiopicus Asparagus Fern, Ground Asparagus, Basket Fern, Sprengi's Fern, Bushy Asparagus, Emerald Asparagus [62425]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus declinatus Bridal Veil, Bridal Veil Creeper, Pale Berry Asparagus Fern, Asparagus Fern, South African Creeper [66908]		Species or species habitat likely to occur within area
Asparagus plumosus Climbing Asparagus-fern [48993]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Eichhornia crassipes Water Hyacinth, Water Orchid, Nile Lily [13466]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana,		Species or species

Name	Status	Type of Presence
Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Sagittaria platyphylla Delta Arrowhead, Arrowhead, Slender Arrowhead [68483]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands	[Resource Information]
Name	State
Booragoon Swamp	WA
Herdsman Lake	WA
Palmer Barracks, Guildford	WA
Perth Airport Woodland Swamps	WA
Swan-Canning Estuary	WA

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-31.9660687 115.88325,-31.96607 115.88325,-31.9661 115.88406,-31.96607 115.88325,-31.96478 115.88167,-31.96607 115.88325,-31.9634 115.87947

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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Appendix F: Biological Survey

AECOM 2021 Causeway Pedestrian & Cyclist Bridge Ecological Survey - D21#165858

AECOM

Main Roads Western Australia
22-Jun-2021

Causeway Pedestrian & Cyclist Bridge Biological Survey

Causeway Pedestrian & Cyclist Bridge Biological Survey

Client: Main Roads Western Australia

ABN: 50 860 676 021

Prepared by

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22-Jun-2021

Job No.: 60612387

AECOM in Australia and New Zealand is certified to ISO9001, ISO14001 AS/NZS4801 and OHSAS18001.

Quality Information

Document	Causeway Pedestrian & Cyclist Bridge Biological Survey 60612387
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Date	22-Jun-2021
Prepared by	Paul Brandon, Shannon de Melo, Jared Leigh and Cassandra Bryan
Reviewed by	Jamie Shaw

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
A	18-Jan-2021	Draft for Internal Review	Jamie Shaw Group Lead - Environment	
B	20-Jan-2021	Draft for Client Review	Jamie Shaw Group Lead - Environment	
C	03-Feb-2021	Draft for Internal Review	Jamie Shaw Group Lead - Environment	
D	08-Feb-2021	Draft for Client Review	Jamie Shaw Group Lead - Environment	
E	08-Apr-2021	Draft for Client Review	Jamie Shaw Group Lead - Environment	
0	4-May-2021	Final	Jamie Shaw Group Lead - Environment	
1	22-Jun-2021	Final	Jamie Shaw Group Lead - Environment	

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Executive Summary

Main Roads Western Australia (Main Roads) commissioned AECOM Australia Pty Ltd (AECOM) to undertake a biological survey for the proposed Causeway Pedestrian & Cyclist Bridge. The objective of the biological survey was to delineate key flora, vegetation, fauna and wetland values of the survey area to inform the environmental assessment and approval process.

A comprehensive desktop assessment was completed to identify the flora, fauna and vegetation communities of conservation significance that may occur on Heirisson Island and the adjacent riverbanks and foreshores of the Swan River in South Perth, Victoria Park and East Perth. The results identified five communities, 98 flora and 67 fauna species of conservation significance that have the potential to occur in the survey area.

AECOM completed a detailed flora and vegetation assessment in November 2020. Areas of native vegetation were traversed on foot and subject to detailed surveys including flora quadrats and opportunistic recordings.

The Subtropical and Temperate Coastal Saltmarsh Threatened Ecological Community (TEC) was recorded on Heirisson Island fringing the artificial wetland on the southwest side. This TEC is listed as Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). A detailed assessment was conducted to verify its presence, which extends for 3.22 ha. This TEC is synonymous with a Priority 3 community listed by Department of Biodiversity, Conservation and Attractions (DBCA), known as Western Australian Priority Ecological Community (PEC) Subtropical and Temperate Coastal Saltmarsh.

No threatened flora listed under the EPBC Act or *Biodiversity Conservation Act 2016* (BC Act) were recorded during the survey. No native endemic species listed as Priority by DBCA were recorded in the survey area.

AECOM completed a basic fauna and targeted black cockatoo survey in November 2020, in compliance with relevant guidelines. The basic fauna survey primarily focused on verifying the findings of the desktop assessment and mapping fauna habitat, while also searching for signs of conservation significant fauna species. The targeted black cockatoo survey was conducted to identify potential breeding, roosting and foraging habitat.

The survey area has been extensively cleared and modified and includes large areas of parkland, significant numbers of native and introduced trees, maintained lawns and gardens, and wetlands and riparian vegetation. Three broad fauna habitats were defined and mapped, based predominantly on vegetation, landform and soils. These comprise Scattered Trees; Wetland, River and Riparian Vegetation; and Parkland and Maintained Gardens. Quality of the habitat varies considerably. These modified and fragmented areas generally only provide habitat for wetland and avian species, and those species that tolerate urbanised environments. Thirty-three vertebrate fauna species were recorded during the field survey, comprising 31 bird and two mammal species. A large majority of these species were wetland and waterbird species, with minimal species of conservation significance.

The survey area was also found to contain 416 native and introduced eucalypts with a diameter at breast height (DBH) > 500 mm. Of these, 159 (38%) were River Red Gum *E. camaldulensis*, 146 (35%) were Flooded Gum *E. rudis*, 15 (4%) were Sugar Gum *E. cladocalyx*, and 12 (3%) were Tuart *E. gomphocephala*. The remaining 84 (20%) trees were a mix of native and introduced species. One hollow with a diameter greater than 100 mm, which may potentially be utilised by breeding black cockatoos, was identified within a River Red Gum *E. camaldulensis*. Roosting sites were searched for throughout the survey area, but no black cockatoo roost sites were identified. Although there are significant numbers of large mature eucalypts within the survey area for a metropolitan area, there are minimal Marri *Corymbia calophylla*, Jarrah *Eucalyptus marginata* and proteaceous species, and the habitats present generally only provide Negligible to Low Quality value foraging habitat for black cockatoos. Approximately 16.75 ha of Negligible value foraging habitat was mapped for Carnaby's Cockatoo *Calyptorhynchus latirostris* and approximately 12.14 ha of Negligible to Low Quality foraging habitat for the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* within the survey area.

The biological survey was completed successfully without significant limitations.

1.0 Introduction

1.1 Background

The Perth Causeway shared path is a popular walking and cycling route in the Perth metropolitan area, connecting the Perth CBD and Victoria Park. The existing 2 meter (m) wide path is currently located on the western side of the two traffic bridges and has been identified as a location for cyclist safety concern.

Multiple government agencies have been collaborating and investigating options for developing an improved walking and cycling link across Heirisson Island. Main Roads Western Australia (Main Roads) is now proposing to deliver the new Causeway Pedestrian and Cyclist Bridge. The current preferred option is a 6 m wide bridge with cable stay design that has two spans (Point Fraser span and McCallum Park span) and approximately three pylons in the Swan River.

1.2 Location

The survey area is located primarily on Heirisson Island and the adjacent riverbanks and foreshores of the Swan River in South Perth, Victoria Park and East Perth. The extent of the survey area, including the potentially impacted areas of the Swan River extends 95.60 ha within the Local Government Areas of South Perth, Victoria Park and City of Perth (Figure 1).

1.3 Objectives

Main Roads has engaged AECOM to complete a biological survey of the survey area to delineate key flora, fauna and wetland values to inform the environmental assessment and approval process. The specific objects of the biological survey were to:

- Undertake a desktop study comprised of a review of reports and spatial data that are relevant for the survey area.
- Conduct a targeted and detailed vegetation and flora field survey and basic fauna survey (as described in the EPA (2016a, 2020) flora and fauna survey technical guides).
- Undertake vegetation unit mapping to characterise the survey area according to the National Vegetation Information System (NVIS) structure and floristics.
- Analyse any potential areas of Threatened Ecological Communities (TECs) or Priority Ecological Communities (PECs) identified in the desktop study to determine the floristic composition vegetation classification and determine the key diagnostic characteristics and condition thresholds for classification as TEC/PEC as per the relevant approved conservation advice.
- Conduct wetland assessment including mapping riparian vegetation and describing wetlands present based on the Geomorphic Wetlands of the Swan Coastal Plain (SCP) dataset.
- Targeted searches for Threatened and Priority flora and fauna species identified in the desktop assessment and determine the population size and extent of priority flora species within the survey area.
- Undertake black cockatoo habitat assessment to identify black cockatoo foraging, roosting and breeding habitat within the survey area.

2.0 Legislative Framework

2.1 Overview

Table 1 summarises the key legislation and guidance governing the protection and management of Western Australia's significant flora, fauna and communities.

Table 1 Relevant legislation, regulations and guidance

Legislation	Purpose
Commonwealth of Australia	
Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)	Provides for the protection of the environment and the conservation of biodiversity.
EPBC Act Referral Guidelines for Three Threatened Black Cockatoo Species, (DSEWPAC, 2012)	These guidelines are intended to assist proponents in determining whether an action needs to be referred to the Australian Government. Definitions of habitat are provided as are criteria used to judge significant impact for these black Cockatoo species.
Western Australia	
Biodiversity Conservation Act 2016 (BC Act)	The BC Act provides for the conservation and protection of Western Australia's wildlife including flora species, vegetation communities and fauna species.
Environmental Protection Act 1986 (EP Act)	Preventing, controlling and abating environmental harm and conserving, preserving, protecting, enhancing and managing the environment.
Biosecurity and Agriculture Management Act 2007 (BAM Act)	Provides for the management, control and prevention of certain plants and animals, and for the protection of agriculture and related resources generally.
EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016a)	Provides guidance to ensure adequate flora and vegetation data of an appropriate standard are obtained and used in environmental impact assessment (EIA).
EPA Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment. EPA, Western Australia (EPA, 2020)	Provides advice on fauna sampling techniques and methodologies for different regions of the State and the analysis, interpretation and reporting requirements for EIA.

2.2 Federal Legislation – EPBC Act

2.2.1 Matters of National Significance

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the main piece of Federal legislation protecting biodiversity in Australia. All Matters of National Environmental Significance (MNES) are listed under the EPBC Act. These include:

- listed threatened species and ecological communities
- migratory species protected under international agreements
- Ramsar wetlands of international importance
- the Commonwealth marine environment
- world Heritage properties
- national Heritage places
- Great Barrier Reef Marine Park
- a water resource, in relation to coal seam gas development and large coal mining development
- nuclear actions.

If an action is likely to have a significant impact on a MNES this action must be referred to the Minister for the Environment for a decision on whether assessment and approval is required under the EPBC Act.

2.2.2 Flora and Fauna

Species at risk of extinction are recognised at a Commonwealth level and are categorised in one of six categories as outlined in Table 2.

Table 2 Categories of species listed under Schedule 179 of the EPBC Act

Conservation	Code Category
Ex	**Extinct Taxa** which at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.
ExW	**Extinct in the Wild** Taxa which is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.
CE	**Critically Endangered** Taxa which at a particular time if, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with the prescribed criteria.
E	**Endangered** Taxa which is not critically endangered and it is facing a very high risk of extinction in the wild in the immediate or near future, as determined in accordance with the prescribed criteria.
V	**Vulnerable** Taxa which is not critically endangered or endangered and is facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with the prescribed criteria.
CD	**Conservation Dependent** Taxa which at a particular time if, at that time: the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered the following subparagraphs are satisfied: • the species is a species of fish • the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised the plan of management is in force under a law of the Commonwealth or of a State or Territory cessation of the plan of management would adversely affect the conservation status of the species.

2.2.3 Vegetation Communities

Vegetation communities can be classified as TECs under the EPBC Act. The EPBC Act protects Australia's ecological communities by providing for:

- identification and listing of ecological communities as threatened
- development of conservation advice and recovery plans for listed ecological communities
- recognition of key threatening processes
- reduction of the impact of these processes through threat abatement plans.

Categories of federally listed TECs are described in Table 3.

Table 3 Categories of TECs that are listed under the EPBC Act

Code	Category
CE	Critically Endangered If, at that time, it is facing an extremely high risk of extinction in the wild in the immediate future.
E	Endangered If, at that time, it is not critically endangered and is facing a very high risk of extinction in the wild in the near future.
V	Vulnerable If, at that time, it is not critically endangered or endangered, and is facing a high risk of extinction in the wild in the medium-term future.

2.3 Western Australian Legislation

2.3.1 Flora and Fauna

Plants and animals that are considered threatened and need to be specially protected because they are under identifiable threat of extinction are listed under the BC Act. These categories are defined in Table 4.

Table 4 Conservation codes for WA flora and fauna listed under the *Biodiversity Conservation Act 2016*

Code	Category
CR	**Critically Endangered** Threatened species considered to be "facing an extremely high risk of extinction in the wild in the immediate future".
EN	**Endangered species** Threatened species considered to be "facing a very high risk of extinction in the wild in the near future".
VU	**Vulnerable species** Threatened species considered to be "facing a high risk of extinction in the wild in the medium term future"
EX	**Extinct species** Species where "there is no reasonable doubt that the last member of the species has died",
EW	**Extinct in the wild species** Species that "is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form".
Specially Protected Species	
MI	**Migratory birds** Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth. Includes agreements between Govt. of Australia and governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), relating to the protection of migratory birds.
CD	**Special conservation** Fauna of special conservation need, being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
OS	**Other specially protected species** Special protection for reasons other than those already mentioned.

Species that have not yet been adequately surveyed to warrant being listed under the BC Act, or are otherwise data deficient, are added to a Priority Lists under Priorities 1, 2 or 3 by the State Minister for Environment. Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. Categories and definitions of Priority Flora and Fauna species are provided in Table 5.

Table 5 Conservation codes for WA flora and fauna as listed by the Department of Biodiversity, Conservation and Attractions

Code	Category
P1	**Priority One – Poorly Known Species** Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and Railway Reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes.
P2	**Priority Two – Poorly Known Species** Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes.
P3	**Priority Three – Poorly Known Species** Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them.
P4	**Priority Four – Rare, Near Threatened and other species in need of monitoring** a. Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change. These species are usually represented on conservation lands. b. Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent. c. Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

2.3.2 Vegetation Communities

TECs are naturally occurring biological assemblages that occur in a particular type of habitat and that may be subject to processes that threaten to destroy or significantly modify the assemblage across its range. TECs are listed by both State and commonwealth legislation.

Vegetation communities in Western Australia are described as TECs if they have been endorsed by the Western Australian Minister for Environment following recommendations made by the Threatened Species Scientific Committee. Categories of TECs are defined in Table 6.

Department of Biodiversity, Conservation and Attractions (DBCA) maintains a database of State listed TECs, which is available for online searches via its website. Possible TECs that do not meet survey criteria or are not adequately defined are listed as PECs under Priorities 1, 2 and 3. Ecological communities that are adequately known and are rare but not threatened, or meet criteria for Near Threatened, or that have been recently removed from the threatened list, are placed in Priority 4. Conservation dependent communities are classified as Priority 5. PECs are endorsed by the Minister for Environment and are described in Table 7.

DBCA requires that all Priority and Threatened ecological communities are considered during environmental impact assessments and clearing permit applications.

There is currently no formal protection afforded to TECs or PECs listed at the State level.

Table 6 Conservation codes for State listed ecological communities

Code	Category
PD	Presumed Totally Destroyed
CR	Critically Endangered
EN	Endangered
VU	Vulnerable

Table 7 Categories for Priority Ecological Communities

Code	Category
P1	Priority One: poorly-known ecological communities
P2	Priority Two: poorly-known ecological communities
P3	Priority Three: poorly known ecological communities
P4	Priority Four: ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened, or that have been recently removed from the threatened list.

2.3.3 Biosecurity and Agriculture Management Act 2007

Biosecurity is the management of the risk of animal and plant pests and diseases entering, emerging, establishing or spreading in WA to protect the economy, environment and community. Biosecurity is managed under the *Biosecurity and Agriculture Management Act 2007* (BAM Act), which came into effect 1 May 2013. Exotic animals and plants can become an invasive species if they can establish in new areas where local conditions are favourable for their growth. Each organism listed under the BAM Act comes with certain legal / import requirements:

- Declared Pest, Prohibited - s12. Prohibited organisms are declared pests by virtue of section 22(1), and may only be imported and kept subject to permits.
- Permitted - s11. Permitted organisms may be subject to an import permit if they are potential carriers of high-risk organisms.
- Declared Pest - s22(2). Declared pests may be subject to an import permit if they are potential carriers of high-risk organisms, and may also be subject to control and keeping requirements once within Western Australia.
- Permitted, Requires Permit - r73. Regulation 73 permitted organisms may only be imported subject to an import permit.

Declared pests can be assigned to a C1, C2 or C3 control category under the Biosecurity and Agriculture Management Regulations 2013:

- C1 Exclusion - Organisms that should be excluded from part or all of Western Australia.
- C2 Eradication - Organisms that should be eradicated from part or all of Western Australia.
- C3 Management - Organisms that should have some form of management applied that will alleviate the harmful impact of the organism, reduce the numbers or distribution of the organism or prevent or contain the spread of the organism.
- Unassigned - Declared pests that are recognised as having a harmful impact under certain circumstances, where their subsequent control requirements are determined by a Plan or other legislative arrangements under the BAM Act.

2.3.4 Communities of Local, Regional and National Significance

Significant flora and vegetation units need to consider a number of features other than statutory listings in accordance with the Flora and Vegetation Environmental Factor Guideline (EPA, 2016b). These include the following:

- Providing an important function required to maintain the ecological integrity of the land system including soil and surface stability
- Providing a local refuge for fauna
- Dependency on tidal movement
- Acting as a surface water catchment
- Restricted distribution
- Degree of historical impact from threatening processes.

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Survey Area

Survey Area

MAIN ROADS WA

PSP PEDESTRIAN BRIDGE
CAUSEWAY ECOLOGICAL SURVEY

Figure
1

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3.0 Existing Environment

3.1 Climate

The survey area is located approximately in the central Perth Metropolitan region, across the City of Perth, City of South Perth and Town of Victoria Park, in Western Australia. This region experiences a Mediterranean climate, which is characterised by warm to hot dry summers and mild to cool wet winters.

The Mediterranean climate in Australia is a result of the Indian Ocean High, a high-pressure cell that shifts towards the poles in summer and the equator in winter, playing a major role in the formation of the deserts of Western Australia, and the Mediterranean climate of southwest and south-central Australia. Precipitation occurs during winter months, with the possibility of some summer storms.

The nearest Bureau of Meteorology (BoM) weather station with comprehensive rainfall and temperature data is the Perth Metro (station 009225) with data from 1994 to 2020. The months immediately preceding the field survey (July to October) had significantly lower (mean of 30 mm less) than average rainfall (Figure 2). Rainfall was higher than average in Summer and Autumn 2020. However, overall rainfall in 2020 is lower than the historical average.

The survey area is largely comprised of landscaped parkland and areas of remnant native and planted trees. Areas of native remnant vegetation are likely to be driven more by the water quality of the Swan River rather than rainfall. As such, rainfall is unlikely to have limited the ability to collect biological data in the survey area.

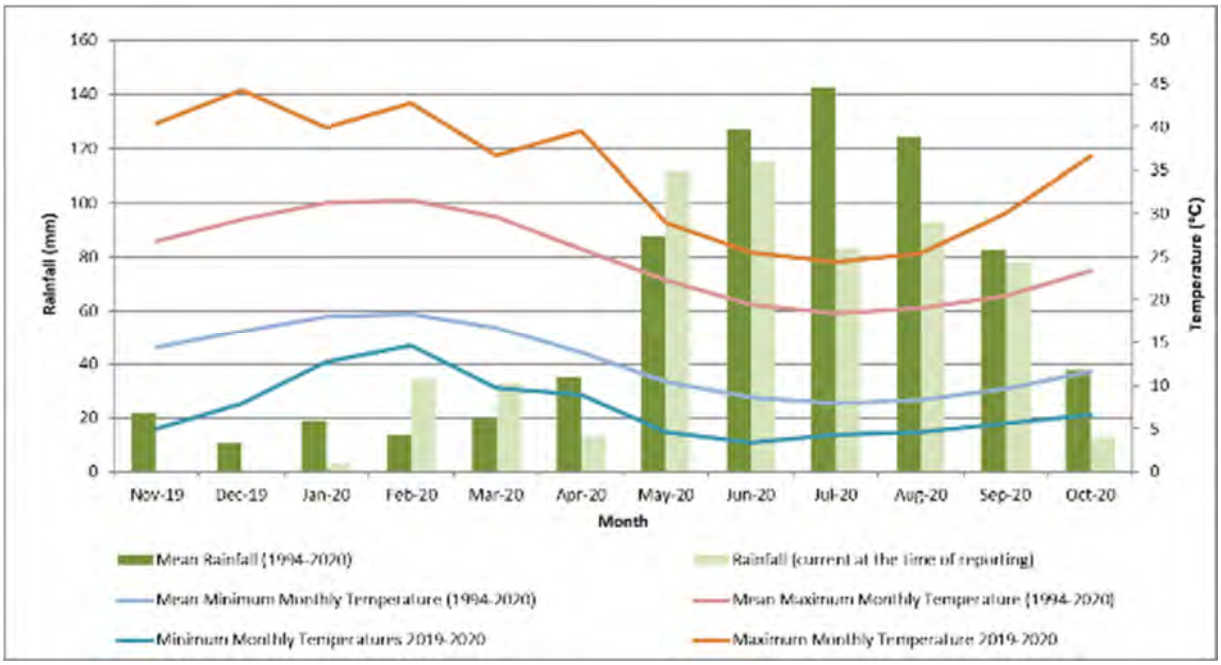


Figure 2 Perth Metro weather station (009225) climate data (BoM, 2020)

3.2 Landforms

Almost the entirety of the survey area (91.78 ha) is characterised as the Vasse soil landscape system described as poorly drained estuarine flats of the SCP. Characterised as tidal flat soil, saline wet soil and pale deep sand, with samphire, sedges and paperbark woodland (Wyrwoll, 2003). A small subsection (3.77 ha) in the north west of the survey area is characterised as the Spearwood dune system of dune ridges with shallow to moderately deep siliceous yellow-brown sands with very common limestone outcrops (Wyrwoll, 2003).

The soil of the survey area is not representative of the prescribed soil system classifications due to the survey area being heavily modified from its pre-European extent. The foreshores of the Swan River that fall within the survey area are comprised of reclaimed land created using uncontrolled landfill in the 1950s. Heirisson Island was originally a group of small swampy islands on a shallow portion of the Swan River, which have subsequently been infilled to create Heirisson Island in its current state (The West Australian, 1950).

3.3 IBRA Regions

The largest regional vegetation classification scheme recognised by the Department of Water and Environmental Regulation (DWER) and the Environmental Protection Authority Services Unit (EPA Services Unit) is the Interim Biogeographical Region of Australia (IBRA). The IBRA regions provide the planning framework for the systematic development of a comprehensive, adequate and representative (CAR) national reserve system. There are 89 recognised IBRA regions across Australia that have been defined based on climate, geology, landforms and characteristic vegetation and fauna (IBRA7, 2012).

The survey area is situated on the SCP 2 (SWA02) subregion, within the SCP bioregion. This is described by Mitchell *et al*. (2002) as a low lying coastal plain, mainly covered with Woodlands. The region is dominated by species of Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. Land use is a mix of agriculture, urban and rural residential, conservation, roads and infrastructure.

3.4 Vegetation

Beard (1979) mapping is used to determine the current extent of remnant vegetation remaining when compared to pre-European vegetation extent. EPA's objective is to retain at least 30% of all pre-European ecological communities, which is consistent with recognised retention levels (EPA, 2015).

Two pre-European vegetation associations exist within the survey area, including:

- Vegetation association 6- Medium woodlands of Tuart and Jarrah. This association extends across Heirisson Island and the South Perth foreshore. The Bassendean vegetation association has 28.72% of its pre-European extent remaining in Western Australia (WA) with 24.14% remaining in the City of Perth and 2.06% remaining in the City of South Perth (Govt. of WA, 2019).
- Vegetation association 1001 extends across the south eastern section of the survey area, which falls within the Town of Victoria Park and is characterised by medium, very sparse woodland; Jarrah, with low woodland; Banksia & Casuarina mosaic: shrublands. This vegetation system has 14.77% of its pre-European extent remaining in WA and 0.83% remaining within the Town of Victoria Park (Govt. of WA, 2019).

Vegetation complexes in the survey area have been defined by Heddle *et al*. (1980) and are based on vegetation in association with landforms and underlying geology. There are two vegetation complexes within the survey area:

- Bassendean Complex - Central and South: Vegetation ranges from woodland of *Eucalyptus marginata* (Jarrah) - *Allocasuarina fraseriana* (Sheoak) - *Banksia* species to low woodland of *Melaleuca* species, and sedgelands on the moister sites. This area includes the transition of *Eucalyptus marginata* (Jarrah) to *Eucalyptus todtiana* (Pricklybark) in the vicinity of Perth. The Bassendean complex occurs in a small strip of the south western border of the survey area.
- Vasse Complex: Mixture of the closed scrub of *Melaleuca* species fringing woodland of *Eucalyptus rudis* (Flooded Gum) - *Melaleuca* species and open forest of *Eucalyptus gomphocephala* (Tuart) - *Eucalyptus marginata* (Jarrah) - *Corymbia calophylla* (Marri). Will include areas dominated by *Tecticornia* and *Sarcocornia* species (Samphire) near Mandurah and south of the Capel River.

See Figure 3 for the extent of each vegetation complex within the survey area.

3.5 Wetlands and Watercourses

The survey area extends almost exclusively across wetlands and watercourses, specifically the Swan River and its riverbanks and the artificial lakes on Heirisson Island. The Heirisson Island artificial lakes are classified as a Multiple Use geomorphic wetland. The Swan River, its banks and the remainder of Heirisson Island are classified as a Conservation Category geomorphic wetland.

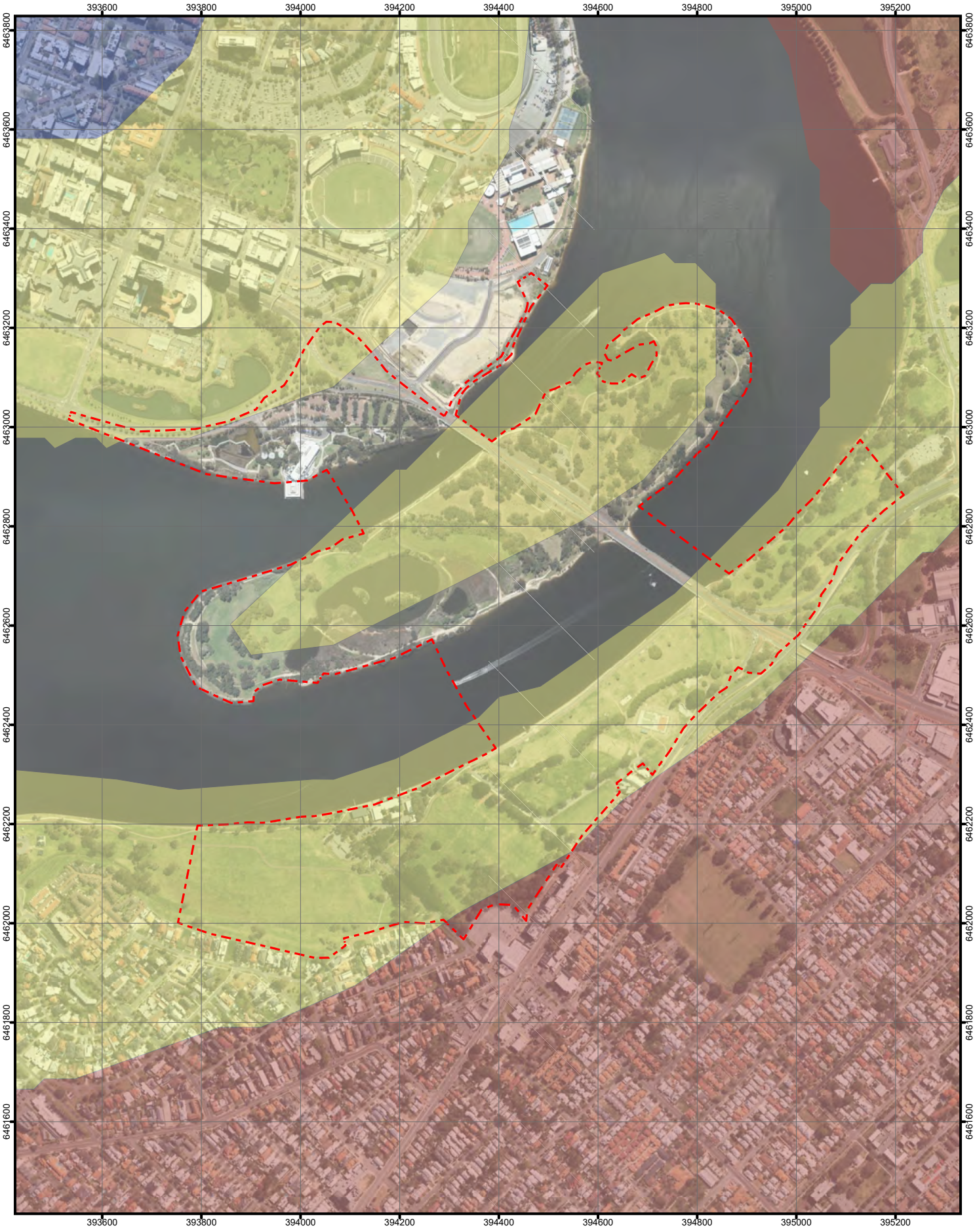
See Figure 4 for the extent of the geomorphic wetlands within the survey area.

Table 8 Wetlands that intersect with the survey area

UFI (and name if available)	Classification	Total Extent (ha)	Extent in Survey Area (ha)
UFI 13,316 Swan River Estuary	Conservation	3,670.11	14.62
UFI 8147 Heirisson Island Artificial Lake	Multiple Use	2.66	2.66
UFI 8148 Heirisson Island Artificial Lake	Multiple Use	0.16	0.16
UFI 8278 Heirisson Island Artificial Lake	Multiple Use	0.57	0.57

3.6 Conservation Areas

The majority of the survey area (71.5 ha), encompassing the Swan River, its riverbanks and Heirisson Island is classified as an Environmentally Sensitive Area (ESA). Much of the survey area located inland from the Swan River in South Perth/Victoria Park is not classified as an ESA. A small section in the north west of the survey area is also not classified as an ESA.



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- Survey Area
- Heddle Vegetation Complexes
- Bassendean Complex-Central and South
- Karrakatta Complex-Central and South
- Vasse Complex

Heddle Vegetation Complexes

MAIN ROADS WA

PSP PEDESTRIAN BRIDGE CAUSEWAY ECOLOGICAL SURVEY

Figure
3

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- Survey Area
- Directory of Important Wetlands (DBCA)

Geormophic Wetlands, Swan Coastal Plain (DBCA)
Management Category

- Conservation
- Multiple Use

Wetlands and Watercourses

MAIN ROADS WA

PSP PEDESTRIAN BRIDGE
CAUSEWAY ECOLOGICAL SURVEY

Figure
4

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4.0 Methodology

4.1 Desktop Assessment

A comprehensive desktop assessment was completed prior to completing the field surveys. The objective was to define the existing environment and determine the significant species and/or communities that may occur in the field survey. This information informed the field survey sample plan.

The desktop assessment utilised the following sources:

- DBCA flora, fauna and communities database searches.
- Protected Matters Search Tool (PMST) with a buffer of 12 km
- WA Museum databases
- NatureMap database
- Atlas of Living Australia (AoLA) database
- Government of Western Australia (GoWA) 2020 databases
- BirdLife Australia (2020a) black cockatoo roosting database
- Publicly available GIS data including Soil Atlas of Australia, surface geology of Australia, Environmentally Sensitive Areas (ESA) database, DBCA managed lands and reserves
- Bureau of Meteorology climate data (BoM, 2020).

Species and communities identified during the desktop study were investigated to determine their likelihood of occurrence in the Survey Area. This assessment was based on known occurrences and their proximity, the date of historical records, and habitat requirements. The assessment of likelihood of occurrence of identified species was implemented using the categories outlined in Table 9.

Table 9 Categories of likelihood of occurrence for species and communities

Likelihood	Flora	Fauna	Communities
Likely to occur	Habitat is present in the survey area and the species has been recorded in close proximity to the survey area	Survey area is within the known distribution of the species, habitat is present in the survey area and the species has been recorded in close proximity to the survey area	Known occurrences of the community in close proximity to the survey area. Vegetation looks the same within the known occurrence and survey area based on aerial imagery. Geographic location is similar to the survey area
May occur	Habitat may be present and/or the species has been recorded in close proximity to the survey area	Survey area is within the known distribution of the species, marginal habitat may be present and/or the species has been recorded in close proximity to the survey area	Known occurrence of the community in the local area, and/or vegetation looks the same within known occurrence and survey area based on aerial imagery. Geographic location is similar to the survey area
Unlikely to occur	No suitable habitat is present and the species has not been recorded in close proximity to the survey area	Survey area is outside the known distribution for the species, or no suitable habitat is present and the species has not been recorded in close proximity to the survey area	Known occurrence of the community in close proximity to the survey area however geographic location does not occur in survey area

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metres

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).Geoscience Australia, Streetpro

LEGEND
- Survey Area
- Track log 05/11/20
- Track log 06/11/20
- Quadrats

Survey Effort

MAIN ROADS WA

PSP PEDESTRIAN BRIDGE CAUSEWAY ECOLOGICAL SURVEY

Figure
5

Map Document: P:\606X\60612387\7097_Causeway PSP Bridge PEIA and Associated Works\900_CAD_GIS\920_GIS\02_MXDs\60612387_7097_Causeway PSP Bridge PEIA and Associated Works.aprx (WyattK2)

A4 size

4.2 Flora and Vegetation

4.2.1 Detailed Flora and Vegetation Assessment

A detailed flora and vegetation assessment was conducted by Botanist Cassandra Bryan (collection permit FB620000289) on 5th and 6th November 2020, in accordance with Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016). Cassandra has 10 years' experience undertaking flora and vegetation assessments, following completion of a Bachelor of Science (Environmental Science) with Honours at Curtin University, majoring in Biology.

Floristic data was collected from six non-permanent 10 x 10 m quadrats within the survey area defined by a measuring tape. Data collected from quadrats included the presence of plant species, their cover abundance, structural composition of vegetation, physical environment, and presence/absence of disturbance. Each Site was given a unique site number, and the following parameters recorded:

- date
- location using hand-held GPS (accuracy of 5 m)
- sample site type (quadrat/relevé and size)
- photograph (northwest corner)
- soil details (type, colour, moisture)
- landform
- vegetation condition using the EPA (2016) scale adapted from Keighery (1994), and description of disturbance
- fire history
- comprehensive species list
    - estimated height
    - estimated percentage cover (for trees both percentage within quadrat and within community was recorded to enable better description of vegetation community).

Flora survey effort and location of detailed site recordings are shown in Figure 5.

Any species unable to be identified in the field were collected for identification in AECOM's in-house herbarium and the specimens and taxonomic references and keys at the Western Australian Herbarium (WAH). Plant collections were dried and frozen in accordance with WAH standards. Nomenclature followed the convention of the WAH.

4.2.2 Vegetation Classification

Vegetation communities were described and mapped based on changes in dominant species composition and landform. Vegetation community descriptions were based on the National Vegetation Information System (NVIS) framework at level V Association (DotEE, 2017a).

Vegetation condition was determined using the EPA (2016) scale adapted from Keighery (1994) condition scale (Table 10). The scale is based on disturbance (e.g. grazing, erosion), degree of alteration to community and habitat structure and site ecology. Areas devoid of native vegetation were mapped as cleared (e.g. roads, infrastructure) and grassed areas as parkland.

Table 10 Bushland condition ratings (EPA, 2016; adapted from Keighery, 1994)

Rating	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance of vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation is no longer intact, and the area is completely or almost completely without native species. These areas are often described as “parkland cleared” with the flora comprising weed or crop species with isolated native trees or shrubs.

4.3 Fauna

4.3.1 Basic Fauna Survey

A basic fauna survey was conducted on 5th and 6th November 2020 by Ecologist Jared Leigh. Jared has over 16 years’ experience in the environmental industry and completed a Bachelor of Science (Environmental) at the University of Western Australia (UWA), majoring in Zoology and Marine Biology. The survey was conducted in accordance with Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (EPA, 2020). The survey was conducted concurrently with the flora and vegetation survey and the targeted black cockatoo survey, which enables consistent mapping of the fauna habitats and vegetation communities.

The field survey was undertaken following completion of the desktop assessment, with the survey primarily focused on verifying the findings of the desktop assessment and identifying and mapping (significant) fauna habitat. Signs of significant fauna species considered likely to utilise the habitats of the survey area were searched for during the basic fauna survey.

Fauna habitats were assessed for specific habitat components, including consideration of structural diversity and refuge opportunities for fauna, in order to determine the potential for these habitats to support significant species. The fauna habitat assessments included:

- location
- general habitat description
- habitat condition and disturbance types
- dominant / characteristic flora species and vegetation layers
- presence and abundance of key habitat features such as large mature trees, small and large hollows, fallen logs, coarse and fine litter, decorticating bark, bare ground, grass, stones and boulders, rock crevices, soil cracks, vines, dense shrubs, water bodies etc.
- presence of fauna and secondary signs (e.g. scats, digging, foraging evidence, tracks, burrows, eggshell, bones, feathers etc.)
- connectivity of habitat.

During the fauna survey, field observations included identifying (via direct and indirect evidence) the presence of significant fauna species and compiling a list of common fauna species. All observations were made during daylight hours of 0700 and 1800.

The taxonomy and nomenclature of vertebrate species for mammals, reptiles and amphibians is consistent with the Western Australian Museum's Checklist of Vertebrates of Western Australia (2020) and the Australian Faunal Directory (https://biodiversity.org.au/afd/mainchecklist) for bird species.

4.3.2 Targeted Black Cockatoo Survey

A targeted black cockatoo survey was conducted in conjunction with the basic fauna survey, by Ecologists Jared Leigh and Cassandra House, and Botanist Cassandra Bryan. The survey targeted the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* and Carnaby's Cockatoo *Calyptorhynchus latirostris* as the survey area is within the known range of both of these species (DSEWPaC, 2012). Only a few records (DBCA threatened species database, 2020 and AoLA, 2020) of Baudin's Cockatoo C*alyptorhynchus baudinii* have been taken near the survey area and this species is only considered a sporadic visitor to the SCP, primarily utilising the Darling Range and associated regions. The survey was conducted to identify potential breeding, roosting and foraging habitat, in accordance with DSEWPaC (2012). The draft Department of the Environment and Energy (DotEE) (2017b) Referral Guidelines were also utilised, predominantly for the foraging assessment methodology.

4.3.2.1 Breeding Habitat

The breeding habitat survey focused on assessing and quantifying eucalypts within the survey area with hollows potentially suitable for breeding black cockatoos or with a Diameter at Breast Height (DBH) >500 mm (or >300 mm *Eucalyptus wandoo and Eucalyptus salmonophloia*).

Details collected for each tree included:

- location coordinates (Samsung Android tablet with a Bad Elf GPS PRO 121153 antenna was utilised to give approximate +/- 2 m accuracy)
- tree species
- DBH
- number of potentially suitable hollows
- hollow details – including dimensions, height from ground, direction, type of hollow, evidence of use etc.

Note that aerial imagery is utilised to assess approximate age of trees, where possible. Note also that tree hollow presence and suitability is assessed from ground level with the use of binoculars. Suitability and utilisation by black cockatoos cannot always be assessed adequately at ground level, and hence the Precautionary Principle is used where appropriate.

4.3.2.2 Roosting Habitat

Carnaby's Cockatoos roost in or near riparian environments or near other permanent water sources, generally within any tall trees, but particularly Flat-topped Yate, Salmon Gum, Wandoo, Marri, Karri, Blackbutt, Tuart, introduced eucalypts and introduced pines. The Forest Red-tailed Black Cockatoo prefers the edges of forests for roosting, within any tall trees, but particularly tall Jarrah, Marri, Blackbutt, Tuart and introduced eucalypt trees (DotEE, 2017b). Potential roosting trees were searched for and assessed during the field survey.

4.3.2.3 Foraging Habitat

The quality of foraging habitat for black cockatoo species was determined through assessing the vegetation and calculating a foraging score using Bamford Consulting Ecologists (BCE) Black Cockatoo Scoring System (Bamford Consulting Ecologists, 2020) (Appendix E). The foraging score provides a numerical value that reflects the significance of vegetation as foraging habitat for black cockatoos, and has been designed to provide the information needed by the Department of Agriculture, Water and the Environment (DAWE) to assess the impact significance and offset requirements. The BCE Black Cockatoo Scoring System methodology is described in Appendix E.

5.0 Survey Limitations

No significant limitations were identified that may impact on the ability to use the data to inform the environmental impact assessment. Limitations of the biological surveys are discussed in Table 11.

Table 11 Limitations of the Causeway bridge biological surveys

Limitation	Flora and Vegetation Survey	Targeted Black Cockatoo Survey	Basic Fauna Survey
Availability of contextual information on the region	**Nil** Sufficient resources for the SCP were available to provide contextual information including Beard (1979) and Heddle *et al*. (1980) vegetation mapping.	**Nil** Sufficient contextual information is available for the SCP and the survey area. Resources utilised to inform the targeted black cockatoo survey include the DBCA database, BirdLife Australia (2020a), GoWA (2018), NatureMap (2020), DotEE (2017b), AoLA (2020) and DSEWPac (2012).	**Nil** Sufficient contextual information is available on the SCP and the survey area. Resources utilised to inform the basic fauna survey include the DBCA database, AoLA (2020), EPA (2020), NatureMap (2020), EPBC Act PMST and various field guides and publications.
Competency/experience of consultant conducting survey	**Nil** The flora and vegetation assessment was led by Cassandra Bryan who has more than 10 years' experience conducting surveys of similar scope.	**Nil** Jared is an ecologist with over 16 years' experience in the environmental industry and has conducted targeted black cockatoo surveys consistently over the past five years. Cassandra House and Cassandra Bryan have conducted multiple biological surveys and targeted black cockatoo surveys on the SCP over the past few years.	**Nil** Jared is an ecologist with over 16 years' experience in the environmental industry and has conducted basic (level 1) fauna surveys in a range of bioregions within Western Australia.

Limitation	Flora and Vegetation Survey	Targeted Black Cockatoo Survey	Basic Fauna Survey
Proportion of flora / fauna identified, recorded and/or collected (based on sampling, timing and intensity)	**Nil** Sampling effort included six quadrats and numerous opportunistic recordings. The *Salicornia* species collected in the artificial wetlands on Heirisson Island lacked identifiable material (flowers) therefore were unable to be distinguished between two species. Mike Hislop at WA Herbarium provided two possible identifications, neither of which represent a significant species.	**Minor to Moderate** The targeted black cockatoo survey was conducted based on DSEWPaC (2012) and DotEE (2017b), and the likelihood of these species utilising the survey area. These surveys were conducted in accordance with the relevant guidelines and standards. Some difficulty was encountered in identifying the occasional eucalypt in the survey area due to lack of buds and fruit on-ground owing to lawn maintenance, and altered morphology of this material (possibly due to fertiliser usage and hybridisation). Lawn maintenance may also have restricted the ability to find foraging evidence.	**Nil** Information gained for a basic terrestrial vertebrate fauna survey was sufficient with all habitats mapped and threatened species searched for in the appropriate areas. Note that marine fish, marine mammal and marine reptile species have generally been omitted from this survey.
Completion (is further work needed)	**Nil** The objectives of the Flora and Vegetation Survey were met in that significant environmental values were able to be recorded and mapped to inform environmental constraints mapping and decision-making for negating environmental impacts.	**Minor** Tree hollow suitability cannot always be assessed adequately at ground level, and hence the Precautionary Principle is utilised where appropriate. The single potentially suitable hollow located within the survey area could be assessed further by utilising a telescopic pole camera, elevated work platforms (EWPs) or specialist tree climbers. Further investigation may be dependent on the final clearing footprint. The objectives of the targeted black cockatoo survey were met.	**Nil** The objectives of the basic fauna survey were met and no further work is required.
Remoteness and/or access problems	**Nil** The entire survey area was able to be accessed.	**Minor** A small fenced area (Department of Water and Environmental Regulations offices) on the banks of the Swan River was not accessible and habitat was largely unassessed within this area.	**Nil** The entire survey area was able to be assessed.

Limitation	Flora and Vegetation Survey	Targeted Black Cockatoo Survey	Basic Fauna Survey
Timing, weather, season, cycle	**Minor** Rainfall was below average across most months between January 2020 and October 2020. Although, the lower than average rainfall was not substantial enough to significantly inhibit the growth of flora. The survey being conducted during late spring limited the amount of flora species that were able to be detected due to germination and flowering periods of many species primarily occurring during late winter (August) and earlier in spring. However, for the purpose of this assessment, it is not considered a significant limitation.	**Nil** No limitations were identified relating to timing, weather, season or cycle.	**Minor** The survey was conducted during a period of reasonable weather in Spring. Although it was limited to one survey period during one year, and during daylight hours, this does not significantly impact a basic fauna survey.
Disturbances (e.g. fire flood, accidental human intervention) which affected results of the survey	**Nil** The botanical survey was not disrupted or impacted.	**Nil** The targeted black cockatoo survey was not disrupted or impacted.	**Nil** The basic fauna survey was not disrupted or impacted.

6.0 Desktop Assessment Results

6.1 Threatened and Priority Ecological Communities

The database searches identified five TECs within a 10 km search radius (Table 12).

The Subtropical and Temperate Coastal Saltmarsh TEC (EPBC Act-listed as Vulnerable) was the only community determined as Likely to occur within the survey area, based on habitat present and distance from historical records, specifically in the vicinity of the western wetland (UFI 8147) on Heirisson Island.

This TEC occurs within a narrow margin of the Australian coastline spanning across six State jurisdictions. The distribution of the TEC is determined by interactions between biota and physical factors, with zonation and mosaics common. The community provides important nursery habitat for fish and prawn species and insects are abundant and an important food source and/or pollinator. Australian Government (2010) published the Approved Conservation Advice from which this information was derived. This TEC overlaps with the survey area.

Table 12 Threatened and Priority ecological communities identified in the desktop study

Community Name	Conservation Status		Distance from Survey Area	Likelihood
	EPBC	WA		
Subtropical and Temperate Coastal Saltmarsh	V	P3	Overlaps survey area	Likely
Banksia Woodlands of the SCP ecological community	E	P3	1.4 km	Unlikely
Clay Pans of the SCP	CE	P1	3.5 km	Unlikely
Corymbia calophylla - *Kingia australis* woodlands on heavy soils of the SCP	E	-	3.0 km	Unlikely
Tuart (*Eucalyptus gomphocephala*) woodlands and forests of the SCP	CE	P3	3.8 km	Unlikely

6.2 Significant Flora

A total of 98 threatened and Priority Flora were identified in the desktop assessment as potentially occurring in the survey area. Of these:

- 30 species are listed as threatened under the EPBC Act and BC Act
- 68 species are listed as Priority by DBCA.

Only one species was found to be ‘Likely’ to occur (Table 13), nine species were determined as ‘May’ occur in the survey area and 88 species were ‘Unlikely’ to occur; based on habitat preferences and age of previous recording.

Native vegetation in the survey area is restricted to planted native trees, wetland fringing vegetation on Heirisson Island and landscaped native revegetation on the East Perth Foreshore. The highly modified vegetation and habitat and isolation of the remnant/native vegetation has reduced the likelihood for significant species to occur.

The comprehensive flora desktop assessment results including habitat, flowering period, latest count date and likelihood of occurrence is presented in Appendix A.

Table 13 Significant flora species 'Likely' to occur

Species	Conservation Status		Habitat
	EPBC Act	State	
Angianthus micropodioides	-	P3	Occurs on saline sandy soils, typically near river edges, saline depressions and claypans. Found in the Eremaean and the South-West Province.

6.3 Fauna

The NatureMap search identified approximately 790 fauna species that have been recorded within the survey and surrounding area. Many of these are historic records of species that would no longer occur within the restricted and fragmented habitats of the local region (e.g. Numbat *Myrmecobius fasciatus fasciatus*). The comprehensive desktop fauna assessment identified 93 significant fauna species that could potentially occur within the survey area. Twenty-six of these species were excluded from the assessment due to being pelagic seabirds (18) or marine species (six marine reptile, one marine fish and one marine mammal species).

The likelihood of occurrence of the remaining 67 fauna species was then determined by assessing the likely presence of suitable habitat in the survey area and reviewing the recent records and distribution of the species. This assessment determined that:

- 10 species are 'likely to occur'
- 26 species 'may occur'
- 31 species are 'unlikely to occur'.

The 10 species that are likely to occur are all avian. Table 14 identifies those significant species that are likely to occur in the survey area and provides relevant ecological information. The significant categories as defined by DBCA, the BC Act and the EPBC Act are outlined in Section 2. The full desktop assessment for all significant fauna species and their likelihood of occurrence in the survey area are presented in Appendix A.

Table 14 Significant fauna species that are likely to occur in the survey area

Scientific Name	Common Name	Conservation Status		Ecology
		State	Federal	
Actitis hypoleucos	Common Sandpiper	IA	Marine / Migratory	The Common Sandpiper is widespread in small numbers throughout Australia, found along all coastlines and in many inland areas (DAWE, 2020). They visit Australia during the non-breeding season. The population when in Australia is concentrated in northern and western Australia (Higgins & Davies, 1996). Areas of national importance within Western Australia include Nuytsland Nature Reserve and Roebuck Bay (Watkins, 1993). The species utilises a wide range of coastal wetlands and some inland wetlands and is mostly found around muddy margins or rocky shores and rarely on mudflats. The Common Sandpiper has been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties (DAWE, 2020).
Calyptorhynchus banksii naso	Forest Red-tailed Black Cockatoo	VU	V	The Forest Red-tailed Black Cockatoo is 55-60 cm in length mostly glossy black with a pair of black central tail feathers, a crest, robust bill and bright red, orange or yellow barring in the tail (Higgins, 1999). Males are distinguished by broad red tail panels that are only visible when taking off or alighting (Higgins, 1999). Requires tree hollows to nest and breed, occurs in forests of Karri *Eucalyptus diversicolor*, Jarrah *E. marginata* and Marri *Corymbia calophylla*, with flocks moving out onto the SCP in search of food from exotic trees such as White Cedar (Johnstone *et al*., undated). Foraging habitat for the species consists of Jarrah and Marri woodlands and forest throughout its range. Has become more common in the Metropolitan area in the past few years.
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	E	Carnaby's Cockatoo is a white-tailed black cockatoo endemic to the south-west of Western Australia. It is a postnuptial nomad and typically moves west soon after breeding. Breeding occurs mainly from early July to mid-December. There has been an apparent shift in its breeding range further west and south since the middle of last century (Johnstone *et al*., 2010). The species nests in hollows in eucalypts, particularly Salmon Gum *Eucalyptus salmonophloia* and Wandoo *E. Wandoo*, but nests have been found in other eucalypts including York Gum *E. loxophleba*), Flooded Gum *E. rudis*, Tuart *E. gomphocephala* and Marri *Corymbia calophylla* (Johnstone *et al.*, 2010). Breeding success is largely dependent on suitable feeding habitat adjacent to the nest site to provide the necessary food for the survival of the chick (Johnstone *et al.*, 2010). Diet consists of an array of Proteaceous and Eucalyptus species. Foraging habitat, including Banksia woodlands, is considered to be habitat critical to the survival of the species (Johnstone *et al.*, 2010).
Charadrius ruficapillus	Red-capped Plover	-	Marine	The Red-capped Plover stands at between 14 cm and 16 cm and occupies most coastal and near coastal environs (Pizzey & Knight, 2007).
Falco peregrinus	Peregrine Falcon	OS	-	The Peregrine Falcon is a medium-sized raptor (length 35-55cm; wingspan 80-105cm) with slate-grey back, a striking charcoal black head and face which contrast with a pale cream bib on the neck and breast (Birdlife Australia, 2020b). A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and migratory (Pizzey & Knight, 2007). This species lays its eggs in recesses of cliff faces, tree hollows or large abandoned nests (Bamford, 2009)
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	Marine / Migratory	The White-bellied Sea-Eagle is a large raptor that has long, broad wings and a short, wedge-shaped tail. It measures 75–85 cm in length and has a wingspan of 180–220 cm. Females weigh between 2.8 and 4.2 kg, and are larger than the males, which weigh between 2.5 and 3.7 kg (Marchant & Higgins, 1993). The White-bellied Sea-Eagle is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. The habitats occupied by the sea-eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, the sea). Birds have been recorded in (or flying over) a variety of terrestrial habitats (Marchant & Higgins, 1993).
Himantopus himantopus	Pied Stilt	-	Marine / Migratory	The Pied Stilt is a large black and white wader with long orange-red legs and a straight black bill. It has black on the back of the neck, a white collar and a red iris. Widely distributed across the Australian mainland. Pied Stilts prefer freshwater and saltwater marshes, mudflats, and the shallow edges of lakes and rivers (Birdlife, 2020b).

Scientific Name	Common Name	Conservation Status		Ecology
		State	Federal	
Hydroprogne caspia	Caspian Tern	MI	Marine	The largest tern in Australia, the Caspian Tern has long, slender backswept wings and a slightly forked tail. The heavy bill is red with a dusky tip. Widespread in coastal regions, from the Great Australian Bight to the Dampier Peninsula. There are sparse records on the coasts east of King Sound and in eastern regions (Higgins & Davies 1996). The Caspian Tern breeds on variable types of sites including low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony or rocky islets or banks.
Oxyura australis	Blue-billed Duck	P4	-	The Blue-billed Duck is a compact diving duck with males having a large scooped bright, light blue bill. The tail is dark with stiff pointed feather tips and is usually held flat on the surface of the water except when in display (Birdlife, 2020b). The Blue-billed Duck is endemic to south eastern and south western Australia. It prefers deep water in large permanent wetlands and swamps with aquatic vegetation. This species of duck is fully aquatic and rarely comes onto land (OoEH, 2018)
Pandion haliaetus	Osprey	MI	Marine / Migratory	The Osprey is a medium-sized raptor with dark-brown to blackish-brown above and white below with a white head and neck; a dark-brown to blackish-brown crest; a black stripe across the eye and ear; a band of reddish-brown, brown or dark-brown streaking across the breast. The breeding range of the Osprey includes the northern coast of Australia from Albany in WA to Lake Macquarie in NSW (DotEE, 2020). The Osprey occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. Found mostly in coastal areas but can travel inland along major rivers. Areas of open fresh, brackish or saline water for foraging is essential for their habitat, visiting various wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps and broad rivers, reservoirs and large lakes. They can also occur over atypical habitats such as heath, woodland or forest when travelling between foraging sites.

7.0 Survey Results and Discussion

7.1 Vegetation

7.1.1 Threatened and Priority Ecological Communities

The presence of the Subtropical and Temperate Coastal Saltmarsh TEC (EPBC Act-listed Vulnerable) has been confirmed to occur in the survey area through an assessment of the key diagnostic characteristics defined in the Conservation Advice (Australian Government, 2010). It is synonymous with the Priority 3 PEC Subtropical and Temperate Coastal Saltmarsh.

Community CoSq is considered to represent the Subtropical and Temperate Coastal Saltmarsh TEC (Coastal Saltmarsh TEC). The national listing focusses on legal protection on remaining areas or patches of this community that are most functional, relatively natural and in relatively good condition (Australian Government, 2010). For this reason, only the vegetation considered in 'Good' or better condition was considered to represent this TEC. This patch includes quadrats 1, 2, 3 and 4 and extends for 3.22 ha; representing 3.37% of the total survey area.

The Coastal Saltmarsh TEC consists mainly of salt-tolerant vegetation. Dominant genera that often occur include, but are not limited to, *Atriplex, Juncus, Salicornia, Suaeda and Tecticornia* (Australian Government, 2010). Community CoSq species' diversity was low and represented by the following: *Salicornia quinqueflora/S. blackiana, Suaeda australis, Juncus kraussii subsp. australiensis, Tecticornia indica* subsp. bidens and **Atriplex prostrata*, further validating the TEC presence. The low species richness of the TEC in the survey area is reflective of the age of the wetland, which was artificially created. Species presence relies on natural recruitment, with the nearest known record of this TEC occurring 2.5 km from the survey area.

The key diagnostic features for this community have been addressed in Table 15. Representative photographs are provided in Plate 1.

Table 15 Key diagnostic features of the Subtropical and Temperate Coastal Saltmarsh TEC

Key Diagnostic Feature	Community in Survey Area
Occurs south of 23° 37' S latitude - from the central Mackay coast on the east coast of Australia, southerly around to Shark Bay on the west coast of Australia (26° latitude), and including the Tasmanian coast and islands within the above range	Yes
Occurs on the coastal margin, along estuaries and coastal embayments and on low wave energy coasts	Yes, along Swan River Estuary
Occurs on places with at least some tidal connection, including rarely-inundated supratidal areas, intermittently opened or closed lagoons, and groundwater tidal influences, but not areas receiving only aerosol spray	Yes, as above
Occurs on sandy or muddy substrate and may include coastal clay pans (and the like)	Yes, soils noted to be sandy
Consists of dense to patchy areas of characteristic coastal saltmarsh plant species (i.e. salt tolerant herbs, succulent shrubs or grasses, that may also include bare sediment as part of the mosaic)	Yes, coastal saltmarsh occupied an average of 100% within a 10x10 m quadrat
Proportional cover by tree canopy such as mangroves, Melaleucas or Casuarinas is not greater than 50%, nor is proportional ground cover by seagrass greater than 50%.	Yes, tree canopy was 1-2%
Condition thresholds	
Patch size greater than 0.4 ha	Yes, 3.22 ha
Ongoing tidal regime	Yes, associated with Swan River Estuary

Plate 1 Coastal Saltmarsh TEC within the survey area

7.1.2 Vegetation Communities

The only native vegetation community described and mapped within the survey area included the samphire shrubland CoSq fringing the artificial wetlands UFI 8147 and UFI 8148.

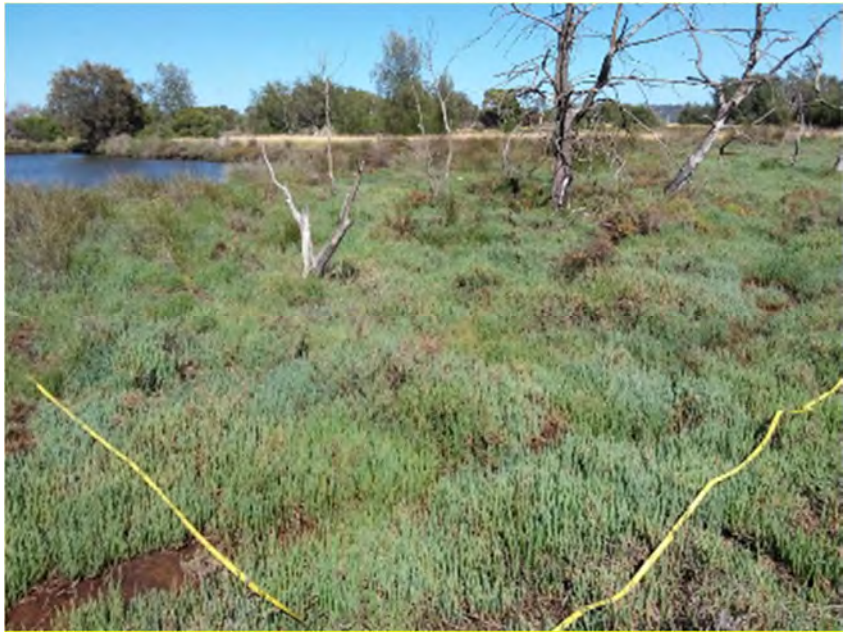
Two planted vegetation communities included the sedgelands, PLJk and PLJp, fringing the artificial wetlands UFI 8278 and north western side of artificial wetland 8147 on the island and along the South Perth riverbank east of the Causeway. These communities represent riparian vegetation. Other areas mapped include cleared, parkland, mixed trees over parkland and mixed trees over revegetation.

The samphire shrubland CoSq represents the Coastal Saltmarsh TEC (EPBC Act-listed Vulnerable); synonymous with the State-listed Priority 3 PEC. This is discussed in Section 7.1.1.

The vegetation communities are described in detail in Table 16 and mapped in Figure 6. A flora species matrix by community is presented in Appendix B with detailed quadrat data presented in Appendix C.

Standing water was mapped on Figure 6, however is not described in Table 16 as it is not considered ‘vegetation’.

Table 16 Vegetation communities including code, description, survey effort, condition and extent

Description	Additional Detail	Photograph
CoSq *Salicornia quinqueflora/ S. blackiana* and *Juncus kraussii* subsp. *australiensis* low closed samphire shrubland with emergent *Casuarina obesa.* Regionally significant: • represents the Subtropical and Temperate Coastal Saltmarsh TEC (EPBC Act-listed as Vulnerable) / PEC (WA - P3) • represents riparian vegetation providing refuge, and important ecological functions associated with soil stability and erosion.	Survey effort: four quadrats Q1, Q2, Q3 and Q4 Extent in survey area: 3.22 ha Condition: Good Represents native vegetation	

Description	Additional Detail	Photograph
PLJk Low planted isolated trees over *Juncus kraussii subsp. australiensis* and *Suaeda australis* low sedgeland. The overstorey is predominantly planted trees, *Eucalyptus* spp. and *Casuarina* spp. over halophyte herbs, sedges and rushes. Represented riparian fringe of the wetlands on Heirisson Island. Locally significant: • represents riparian vegetation that may provide local refuge for fauna species and provides important ecological functions associated with soil stability and erosion.	Survey effort: two quadrats Q5, Q6 Extent in survey area: 0.14 ha Condition: Degraded Represents native vegetation with planted overstorey.	

Description	Additional Detail	Photograph
PLJp Low planted isolated trees over *Juncus pallidus* and *Baumea juncea* low open sedgeland. The overstorey is predominantly planted trees, *Melaleuca* spp. and *Casuarina* spp. over Cyperaceae sedges and rushes. Represents riparian fringe on the South Perth foreshore. Locally significant: • represents riparian vegetation that may provide local refuge for fauna species and provides important ecological functions associated with soil stability and erosion.	Survey effort: observation only Extent in survey area: 0.30 ha Condition: Degraded Represents planted vegetation	

Description	Additional Detail	Photograph
Other, including: • Mixed trees over parkland, comprising native and planted introduced trees (more than 10 years old) over pasture weeds and/or planted vegetation – 23.23 ha • Revegetation, comprising planted gardens – 0.17 ha • Parkland, comprising pasture/lawns – 38.76 ha • Cleared, comprising hardstand including buildings and roads – 11.31 ha • Wetland / Water, comprising water bodies with no vegetation – 18.47 ha.	Extent in survey area: 91.94 ha Represents planted and cleared vegetation	

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0 50 100 150 200
metres

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).Geoscience Australia, Streetpro

LEGEND

Survey Area

Vegetation Communities
- Cleared
- CoSq
- Mixed trees over parkland
- PLJk
- PLJp
- Parkland
- Revegetation
- Water
- Wetland
- Subtropical and Temperate Coastal Saltmarsh (EPBC Act Vulnerable, WA P3)

Vegetation Communities

MAIN ROADS WA

PSP PEDESTRIAN BRIDGE CAUSEWAY ECOLOGICAL SURVEY

Figure
6

Map Document: P:\606X\60612387\7097_Causeway PSP Bridge PEIA and Associated Works\900_CAD_GIS\920_GIS\02_MXDs\60612387_7097_Causeway PSP Bridge PEIA and Associated Works.aprx (WyattK2)

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7.1.3 Vegetation Condition

Vegetation condition within the survey area varied from Good to Completely Degraded. Vegetation in Good condition is restricted to the riparian vegetation fringing the two artificial wetlands on the west side of Heirisson Island that supports the TEC; represented by community CoSq. The riparian vegetation fringing the artificial wetlands, represented by community PLJk, and the riparian vegetation along the South Perth foreshore, represented by community PLJp are classified as Degraded. Areas that support one or more native species, including mixed trees over parkland, and parkland, are mapped as Completely Degraded. Areas devoid of any native species are considered Cleared.

The major contributing factors causing degradation are historical clearing for parkland use, with predominantly isolated trees, shrubs, artificial wetlands and planted native revegetation remaining. Only 3.22 ha (3.37%) of the survey area reflects native vegetation in 'Good' condition, with 0.44 ha (0.46%) considered 'Degraded' and 12.39 ha (12.96%) considered 'Completely Degraded'. The majority of the survey area is considered Cleared (61.08 ha, 63.89%), and there are large areas of water (18.47 ha, 19.32%).

Vegetation condition has been mapped in Figure 7 and extents presented in Table 17.

Table 17 Vegetation condition extent

Condition	Extent (ha)	Percentage of Survey Area
Good	3.22	3.37
Degraded	0.44	0.46
Completely Degraded	12.39	12.96
Cleared	61.08	63.89
Water and Wetlands	18.47	19.32
Total	**95.60**	**100%**

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LEGEND
- Survey Area

Vegetation Condition
- Good
- Degraded
- Completely Degraded
- Cleared

Vegetation Condition

MAIN ROADS WA

PSP PEDESTRIAN BRIDGE CAUSEWAY ECOLOGICAL SURVEY

Figure 7

Map Document: P:\606X\60612387\7097_Causeway PSP Bridge PEIA and Associated Works\900_CAD_GIS\920_GIS\02_MXDs\60612387_7097_Causeway PSP Bridge PEIA and Associated Works.aprx (WyattK2)

A4 size

7.2 Flora

7.2.1 Threatened and Priority Flora

No Threatened flora listed under the EPBC Act or BC Act were recorded during the survey. *Melaleuca viminalis*, was recorded at one location during the survey. In the Kimberley region where it occurs naturally, this species is listed as a Priority 2 species. It is also known to occur in Queensland and New South Wales (Craven et al., 2010).

M. viminalis is in the Myrtaceae family, commonly known as weeping bottlebrush, and commonly grows in and along watercourses. In WA it has been recorded on a stony riverbed, creeklines and around pools (Craven et al., 2010).

The taxon is widely cultivated as a street and garden tree, becoming naturalised as a result in the southwest of WA. The species is considered as Least Concern under the IUCN Red List (IUCN, 2001) as the species is not listed as threatened nationally. Within the survey area this species is therefore not considered to represent a native occurrence of the Priority 2 species.

7.2.2 Diversity

A total of 29 native flora species were recorded representing 19 genera and 8 families. The families Chenopodiaceae and Myrtaceae represented the majority of native species recorded.

Seven introduced species were recorded, including *Melaleuca quinquenervia,* commonly known as the broad-leaved paperbark, and *Casuarina cunninghamiana* subsp. *cunninghamiana,* commonly known as river sheoak, both of which have been widely cultivated and often planted in parklands.

7.3 Wetlands

There are three artificial wetlands that occur within the survey area, and one conservation category wetland that intersects with the survey area (see Figure 4). A brief description of these wetlands is presented in Table 18.

The only native vegetation in the survey area was mapped as riparian vegetation community CoSq (see Figure 6). Vegetation was in ‘Good’ condition, generally lacking floristic diversity, suffering from weed invasion and intersected with cleared access paths.

Riparian vegetation (both native and planted) provides a buffer around the entirety of artificial wetland UFI 8148, partly around the other two wetlands and along part of the South Perth foreshore, providing a local refuge for fauna and provides important ecological functions including soil and surface stability.

Table 18 Description of wetlands that intersect with the survey area

UFI (and name if available)	Classification	Description
UFI 13,316 Swan River Estuary	Conservation	The Swan River is a large water body that supports unique ecological, aesthetic, and cultural values. The vegetation associated with this wetland in the survey area is restricted to planted trees and landscaped parklands. Riparian vegetation was minimal, restricted to less than 1 m along parts of the foreshore.
UFI 8147 Heirisson Island Artificial Lake	Multiple Use	This wetland is on the southwest side of the Causeway on Heirisson Island. It is an artificial basin that now supports the Coastal Saltmarsh TEC. Riparian vegetation provides a buffer around the entirety of this wetland, providing a local refuge for fauna and provides important ecological functions including soil and surface stability.
UFI 8148 Heirisson Island Artificial Lake	Multiple Use	This wetland is on the southwest side of the Causeway on Heirisson Island, adjacent to the larger wetland UFI 8147. It is an artificial basin that now supports the Coastal Saltmarsh TEC. Riparian vegetation provides a buffer around the entirety of this wetland, providing a local refuge for fauna and provides important ecological functions including soil and surface stability.
UFI 8278 Heirisson Island Artificial Lake	Multiple Use	This wetland is on the east side of the Causeway on Heirisson Island. It is an artificial basin with a buffer around its entirety of riparian vegetation that provides a local refuge for fauna and important ecological functions including soil and surface stability.

7.4 Fauna

7.4.1 Basic Fauna Survey

7.4.1.1 Fauna Inventory

Thirty-three vertebrate fauna species were recorded during the field survey. This comprised 31 bird and two mammal species. A large majority of these species were wetland and waterbird species. Generally, most of the 33 fauna species were observed commonly throughout the survey area, with the exception of the Black-eared Cuckoo *Chrysococcyx osculans*, which was heard calling on one occasion on Heirisson Island, and the Australian Shelduck *Tadorna tadornoides*, which was observed once in parkland adjacent a wetland. A complete inventory of fauna species recorded within the survey area is provided in Table 19.

7.4.1.2 Significant Fauna

Six species of significance were recorded within the survey area and surrounding area during the survey. These comprised the Black-faced Cuckoo-shrike *Coracina novaehollandiae*, Magpie Lark *Grallina cyanoleuca*, Silver Gull *Larus novaehollandiae*, Australian Pelican *Pelecanus conspicillatus*, Purple Swamphen *Porphyrio porphyrio bellus* and Straw-necked Ibis *Threskiornis spinicollis*. However, all of these species are listed as Marine under the EPBC Act and are therefore only considered significant when on Federal land. These species are not discussed further as the survey area does not contain any Federal land.

The desktop assessment identified ten significant fauna species that are likely to utilise the habitats of the survey area. These species were searched for where possible, and although not recorded, it is still considered that they could utilise certain habitats within the survey area. These species and habitats are documented in Table 20. The desktop assessment also identified a further 26 significant species that may utilise the habitats within the survey area (refer to Appendix A). These are predominantly marine and migratory waders and waterbirds, and it is still considered that these species may occasionally utilise habitats (predominantly marginal) within the survey area.

Table 19 Vertebrate fauna species recorded within the survey area

Species	Vernacular	Status	Observations
Birds			
Anas superciliosa	Pacific Black Duck	Native	Observed commonly within and adjacent wetland areas
Anhinga novaehollandiae novaehollandiae	Australasian Darter	Native	Observed commonly within and perching adjacent the Swan River
Anthochaera carunculata	Red Wattlebird	Native	Observed commonly throughout survey area
Cacatua roseicapilla roseicapilla	Galah	Native	Observed commonly throughout survey area
Cacatua tenuirostris	Eastern Long-billed Corella	Naturalised exotic	Observed in large flocks on foreshore
Chenonetta jubata	Australian Wood Duck	Native	Observed commonly throughout survey area
Chrysococcyx osculans	Black-eared Cuckoo	Native	Heard adjacent wetland on Heirisson Island
Columba livia	Domestic Pigeon	Naturalised exotic	Observed on foreshore grass
Coracina novaehollandiae melanops	Black-faced Cuckoo-shrike	Native	Observed commonly on Heirisson Island
Corvus coronoides	Australian Raven	Native	Observed commonly within survey area
Cracticus tibicen	Australian Magpie	Native	Many adult and young observed commonly throughout survey area
Cygnus atratus	Black Swan	Native	Group observed on wetlands
Dacelo novaeguineae	Laughing Kookaburra	Naturalised exotic	Observed multiple times perched in eucalypts in survey area
Eolophus roseicapilla	Galah	Native	Commonly observed throughout survey area
Fulica atra	Eurasian Coot	Native	Observed commonly within and adjacent wetland areas
Gavicalis virescens	Singing Honeyeater	Native	Observed commonly throughout the majority of vegetated areas of survey area
Grallina cyanoleuca	Magpie Lark	Native	Observed commonly throughout survey area
Haematopus longirostris	Pied Oystercatcher	Native	Observed a few times foraging on shoreline
Larus novaehollandiae	Silver Gull	Native	Observed commonly throughout survey area
Pardalotus striatus	Striated Pardalote	Native	Heard several times within survey area
Pelecanus conspicillatus	Australian Pelican	Marine	Observed multiple times flying over the
Petrochelidon ariel	Fairy Martin	Native	Several birds observed flying over wetland on Heirisson Island
Phalacrocorax carbo novaehollandiae	Great Cormorant	Native	Observed commonly within and perching adjacent the Swan River
Phalacrocorax melanoleucos	Little Pied Cormorant	Native	Observed commonly within and perching adjacent the Swan River
Phalacrocorax sulcirostris	Little Black Cormorant	Native	Observed several times within wetlands of the survey area
Porphyrio porphyrio bellus	Purple Swamphen	Native	Observed commonly within wetland areas of
Rhipidura leucophrys leucophrys	Willie Wagtail	Native	Commonly observed throughout survey area

Species	Vernacular	Status	Observations
Birds			
Spilopelia senegalensis	Laughing Turtle Dove	Naturalised Exotic	Observed on foreshore
Tadorna tadornoides	Australian Shelduck	Native	Two observed on grassed area adjacent
Threskiornis spinicollis	Straw-necked Ibis	Native	Flock of approx. 10 birds foraging on grass on Heirisson Island
Trichoglossus moluccanus	Rainbow Lorikeet	Introduced	Observed commonly throughout survey area
Mammals			
Canis familiaris familiaris	Domestic Dog	Introduced	Scat observed several times adjacent tracks / paths within survey area
Macropus fuliginosus melanops	Western Grey Kangaroo	Native	Observed commonly in fenced western area of Heirisson Island

7.4.1.3 Introduced Species

Several introduced and naturalised exotic fauna species were observed in the survey area. These comprise:

- Domestic Dog *Canis familiaris familiaris*
- Rainbow Lorikeet *Tricholglossus molaccanus*
- Eastern Long-billed Corella *Cacatua tenuirostris*
- Rock Pigeon *Columba livia*
- Laughing Kookaburra (*Dacelo noaeguineae*)
- Laughing Turtle Dove (*Spilopelia senegalensis*).

The Rainbow Lorikeet *Tricholglossus molaccanus* is listed as a Declared Pest under Section s22 (2) of the BAM Act. The avian species were generally observed commonly throughout the survey area, with Domestic Dog *Canis familiaris familiaris* scat observed commonly adjacent pathways.

7.4.2 Fauna Habitats

The survey area has been extensively cleared and modified and includes large areas of parkland, significant numbers of native and introduced trees, maintained lawns and gardens, and wetlands and riparian vegetation. Quality of the habitat varies considerably. These modified and fragmented areas generally only provide habitat for wetland and avian species, and those species that tolerate urbanised environments.

Three broad fauna habitats were defined and mapped within the survey area, predominantly based on vegetation, landform and soils. These comprise Scattered Trees, Wetland, River and Riparian Vegetation; and Parkland and Maintained Gardens. Hardstand areas (e.g. roads, buildings and pathways) were also mapped but provide minimal fauna habitat. Habitat mapping generally closely aligns with the vegetation mapping in Figure 6.

The most common fauna habitat is the Parkland and Maintained Gardens, due to the large areas of lawn, occupying 39.32 ha (41%) of the survey area. This habitat predominantly contains landscaped areas, garden beds and lawns. Where vegetation (not lawn) exists, it can include an overstorey of mixed native and introduced tree species, and an understorey of mixed native and introduced shrubs and groundcovers. Neither strata are always present and cover is highly variable. The majority of these areas have been planted. Soils are also variable, with the most common being a brown loamy, sandy soil. The highly maintained and modified nature, fragmentation and small size of vegetation patches (areas not lawned) within this habitat type are unsuitable for mammals (unless in the fenced area of Heirisson Island) and medium to large reptiles, with usage predominantly by avian taxa, smaller reptile and amphibian species. This habitat is therefore considered low to moderate quality depending on structural complexity, vegetation patch size and microhabitats present.

Table 20 describes these fauna habitats, includes the area and percentage these cover within the survey area, and the significant fauna species likely to utilise these habitats. Refer to Figure 8 for habitat mapping.

7.4.2.1 Fauna Habitat Linkages

Habitat linkages are typically areas or corridors of vegetation that link (larger) areas of fauna habitat. Linkages are important as they enable fauna to move freely between remnant bushland patches, therefore increasing gene-flow between populations. A study conducted by Gilbert *et al.* (1998) found that corridors and/or linkages do maintain species richness in the fragmented landscapes.

Although the habitats of the survey area have generally been highly modified, it is located on the Swan River and the wetland, river and riparian vegetation will provide a significant habitat corridor for certain taxa. Given the survey area is located within a metropolitan environment with the associated significant levels of clearing and lack of fauna habitat, certain habitats of the survey area will also provide a stepping-stone for avian fauna to move through the metropolitan area.

Table 20 Broad fauna habitats mapped within the survey area

Description	Significant Species Likely to Utilise Habitat	Within Survey Area (ha)	% of Survey Area	Photograph
Scattered Trees This is generally a highly modified habitat containing isolated and small stands of native and introduced trees, over a predominantly cleared understorey. Trees are predominantly over maintained lawns and are often planted. Tree species include Flooded Gum *Eucalyptus rudis,* Red River Gum *E. camaldulensis,* Paperbark *Melaleuca* sp., Peppermint *Agonis flexuosa* and *Casuarina* sp., and other introduced eucalypts and non-eucalypts (street trees). Some trees contain small hollows, though larger hollows are rare and decorticating bark is dependent on tree species and location. Microhabitats beneath trees in the forms of leaf litter, logs and branches, and dense understorey are often absent, with minimal logs and leaf litter in most cases. Soils vary across the survey area, but brown loamy sandy soils are common. The general lack of a mid-storey and an understorey, and the fragmented nature of the trees makes this habitat type unsuitable for most mammal and reptile species, with usage predominantly by avian taxa. Large mature eucalypts and other trees are important within a metropolitan environment with significant clearing, though the limited structural complexity and microhabitats available, and the high degree of modification and fragmentation, generally makes this habitat of moderate quality depending on the tree species present.	• Carnaby's Cockatoo *Calyptorhynchus latirostris* and the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* (refer to Section 4.3.1 for further detail): - eucalypts with suitable DBH provide potential future breeding habitat - larger trees in this habitat provide potential roosting habitat - areas containing foraging species potentially provide foraging habitat • May provide marginal perching and / or nesting habitat for marine and migratory species Osprey *Pandion haliaetus* and White-bellied Sea-Eagle *Haliaeetus leucogaster,* and the threatened Peregrine Falcon *Falco peregrinus.*	17.88	18.7	   
Parkland and Maintained Gardens This habitat contains landscaped areas, garden beds and lawns. The majority of this habitat is lawns, but where vegetation is present, it can include an overstorey of mixed native and introduced tree species, and an understorey of mixed native and introduced shrubs and groundcovers. Neither strata is always present and cover is highly variable. The majority of these areas have been planted. Soils are also variable, with the most common being a brown loamy, sandy soil. The majority of these areas are also maintained on a regular basis, generally reducing microhabitat availability. This habitat contained various amounts of smaller fallen branches, logs, decorticating bark, mulch layers and bare ground, occasional dense understorey, with minimal rocks and larger logs. Any hollows located within the vegetated areas are generally also small. Where vegetation is present, the maintained and modified nature, fragmentation and vegetation patch size makes these areas unsuitable for mammals (unless in the fenced area of Heirisson Island) and medium to large reptiles, with usage predominantly by avian taxa, smaller reptile and amphibian species. The lawned areas are only likely to be utilised by certain avian species. This habitat is therefore considered low to moderate quality depending on structural complexity, vegetation patch size and microhabitats present.	• Carnaby's Cockatoo *Calyptorhynchus latirostris* and the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* (refer to Section 4.3.1 for further detail): - eucalypts with suitable DBH provide potential future breeding habitat - larger trees in this habitat provide potential roosting habitat - areas containing foraging species potentially provide foraging habitat • May provide marginal perching and / or nesting habitat for marine and migratory species Osprey *Pandion haliaetus* and White-bellied Sea-Eagle *Haliaeetus leucogaster,* and the threatened Peregrine Falcon *Falco peregrinus* (where larger trees are present).	39.32	41.1	   

Description	Significant Species Likely to Utilise Habitat	Within Survey Area (ha)	% of Survey Area	Photograph
Wetlands, River and Riparian Vegetation This habitat is highly varied and includes all wetland, saltmarsh, riparian vegetation, river and corresponding shoreline within the survey area. The majority of these areas have been modified to some degree, or are completely artificial. The various size wetlands on Heirisson Island and on the northern banks of the Swan River are variable in nature and range in habitat quality, with some impacted by weeds, rubbish and building rubble. Riparian vegetation present ranges from Paperbark *Melaleuca* sp., Flooded Gum *Eucalyptus rudis* and Sheoak *Allocasuarina* sp. to reeds, sedges and samphires, with most areas modified to some degree. River shoreline habitats are generally highly modified and varied, and include riparian vegetation; artificial rock and brick walls; and bare sandy, rocky and silty areas. This habitat is considered moderate to high quality for a metropolitan environment, and is likely to predominantly provide habitat for bird, amphibian and small reptile species. Note that marine fish, mammal and reptile species have generally been omitted from this assessment.	• Carnaby's Cockatoo *Calyptorhynchus latirostris* and the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* (refer to Section 4.3.1 for further detail): – eucalypts with suitable DBH provide potential future breeding habitat – larger trees in this habitat provide potential roosting habitat – areas containing foraging species potentially provide foraging habitat • May provide marginal habitat for several marine and migratory species including the Osprey *Pandion haliaetus,* Common Sandpiper *Actitis hypoleucos*, Red-capped Plover *Charadrius ruficapillus*, White-bellied Sea-Eagle *Haliaeetus leucogaster*, Pied Stilt *Himantopus himantopus*, Caspian Tern *Hydroprogne caspia,* • May also provide marginal habitat for the threatened Peregrine Falcon *Falco peregrinus* where larger eucalypts are present.	27.50 (including water)	28.8	   
Hardstand These are roads, buildings, carparks, pathways and other hardstand areas which provide no fauna habitat.	None	10.89	11.4	

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LEGEND
- Survey Area

Fauna Habitat
- Hardstand
- Parkland and Maintained Gardens
- Scattered Trees
- Wetland, River and Riparian Vegetation

Fauna Habitat

MAIN ROADS WA

PSP PEDESTRIAN BRIDGE CAUSEWAY ECOLOGICAL SURVEY

Figure 8

Map Document: P:\606X\60612387\7097_Causeway PSP Bridge PEIA and Associated Works\900_CAD_GIS\920_GIS\02_MXDs\60612387_7097_Causeway PSP Bridge PEIA and Associated Works.aprx (WyattK2)

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7.4.3 Targeted Black Cockatoo Survey

7.4.3.1 Ecology

7.4.3.1.1 Carnaby's Cockatoo

Carnaby's Cockatoo *Calyptorhynchus latirostris* is endemic to the southwest of Western Australia, extending from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin. This black cockatoo has a white patch on its cheek, white bands on its tail, and a strong curved bill. Carnaby's Cockatoo is a seasonal visitor to the SCP, which provides important foraging and roosting habitat during the non-breeding season.

Carnaby's Cockatoo feeds on seeds, nuts and flowers of a variety of native and exotic plants. Feed plants include the various proteaceous species (e.g. *Banksia*, *Grevillea* and *Hakea*), Marri *Corymbia calophylla*, Jarrah *Eucalyptus marginata*, and seeds from the cones of Pine *Pinus* sp. trees. Cockatoo flocks follow vegetation corridors and actively avoid cleared and open areas when moving between roosting, water and food resources. Habitat fragmentation increases the distances cockatoos need to travel between resources. Proximity of foraging habitat and water has been demonstrated to be critical to support roosting and breeding sites (Le Roux, 2017).

Carnaby's Cockatoo displays strong pair bonds and nest in the hollows of live or dead mature eucalypts including Salmon Gum *Eucalyptus salmonophloia*, York *Gum E. loxophleba* subsp*. loxophleba*, Flooded Gum *E. rudis*, Karri *E. diversicolor,* Wandoo *E. wandoo* and Tuart *E. gomphocephala* and Marri *Corymbia calophylla*, (DSEWPaC, 2012). Nest hollows generally range from 2.5-12 m above ground, size of entrance from 23-30 cm and depth of hollows from 1-2.5 m (Johnstone and Storr,1998).

Carnaby's Cockatoo has undergone a dramatic decline of approximately 50 percent in the past 45 years, with the main contributing factors the clearing of core breeding habitat in the Wheatbelt, the deterioration of nesting hollows, and clearing of foraging habitat.

Breeding habitat for this species occurs in the Wheatbelt, Jarrah Forest and South Coast regions, and this species appears to be expanding its current breeding range westward and south into the Jarrah-Marri forests of the Darling Range and into the Tuart forests of the SCP (Johnstone *et al.,* 2010). After breeding, Carnaby's Cockatoo disperse to the higher rainfall coastal areas of the south-west of Western Australia to feed in late December to July. Breeding has been recorded from early July to mid-December.

Carnaby's Cockatoo was not observed directly during the survey.

7.4.3.1.2 Forest Red-tailed Black Cockatoo

The Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso* is endemic to the south-west humid and semi-humid zones of Western Australia, where it inhabits dense Jarrah, Karri and Marri forests that receive more than 600 mm average annual rainfall (DSEWPaC, 2012). It has a pair of black central tail feathers and a bright red, orange or yellow barring on the tail.

This species predominantly feeds in eucalypt forests, preferring Marri *Corymbia calophylla* and Jarrah *Eucalyptus marginat*a seeds, but also feeding on Blackbutt *E. patens*, Albany Blackbutt *E. staeri*, Karri *E. diversicolor*, Sheoak *Allocasuarina sp.* and Snottygobble *Persoonia longifolia* (Johnstone, 2016 pers. comm.).

Forest Red-tailed Black Cockatoo are monogamous and pairs nest in tree hollows from 6.5 to 33 m above ground. Most nests are in very large and very old, mature Marri (Johnstone, Kirkby & Sarti, 2013), though they will nest in other eucalypts such as Tuart (Johnstone, 2016 pers. comm.). Breeding habitat for this species occurs in the eastern margins of the Jarrah forests of the Wheatbelt, and within the Jarrah Forest regions, and the Forest Red-tailed Black Cockatoo is expanding its current breeding range with small patches of breeding habitat now being utilised across the SCP.

The Forest Red-tailed Black Cockatoo was not directly observed within or adjacent the survey area during the field survey.

7.4.3.2 Breeding Habitat

Although there are significant numbers of large mature eucalypts with a DBH > 500 mm within the survey area, these have predominantly been planted within the last 80 years, and currently do not generally contain suitable hollows for utilisation by breeding black cockatoos. Hollow formation in eucalypt trees is a result of a number of processes including fungal attack, termites and fire, and the propensity for hollow formation varies between tree species (Whitford, 2002). Age of trees is also an important indicator, and studies show that hollows suitable for black cockatoos may not begin to appear in eucalypts until they are well over 100 to 200 years old (Johnstone *et al*., 2013; Whitford and Williams, 2002).

DSEWPac (2012) states that all trees of all ages and size are potentially important for maintaining breeding in the long term through maintaining the integrity of the habitat and allowing for recruitment of trees to provide future nest hollows. However, DSEWPaC (2012) also notes that maintaining the long-term supply of trees of a size to provide suitable nest hollows is particularly important in woodland stands that are known to support black cockatoo breeding. The survey area provides potential future breeding trees, significant in a metropolitan environment. The survey area was found to contain 416 native and introduced eucalypts with a DBH > 500 mm. Of these, 159 (38%) were River Red Gum *E. camaldulensis*, 146 (35%) were Flooded Gum *E. rudis*, 15 (4%) were Sugar Gum *E. cladocalyx*, and 12 (3%) were Tuart *E. gomphocephala*. The remaining 84 (20%) trees were a mix of native and introduced species. The majority of the above trees were likely planted.

Hollow entrances need to be at least 100 mm in diameter in order to be suitable for breeding black cockatoos. One of the 416 trees contained one hollow with a diameter greater than 100 mm (Tree ID 67 - River Red Gum *E. camaldulensis*). The tree was also observed to have chewing around the hollow entrance and Galahs present. On the SCP most black cockatoo breeding records, particularly for Carnaby's Cockatoo are in Tuart (Johnstone & Kirkby, 2011). Refer to Table 21 for details, and Figure 9 for the location, of Tree ID 67.

Black cockatoos face strong competition for nesting hollows from other species, with BirdLife Australia (2018) finding 6% of natural black cockatoo hollows and 10 % of artificial black cockatoo hollows occupied by competitors. The type and dimensions of hollows appear to be significant factors in hollow competition. Most parrots and Galahs prefer smaller hollows with side/spout entrances rather than the black cockatoo's preferred hollows with large, chimney/vertical entrances, which means that they rarely compete with black cockatoos for natural hollows (BirdLife Australia, 2018). The European Honeybee also tend not to like vertical entry hollows due to the amount of ventilation (Johnstone and Kirkby, 2007). Ducks seem to like large hollows and are direct competitors for natural hollows with any type of entrance. BirdLife Australia (2018) also note that hollows may potentially be utilised by multiple species throughout the year, with ducks normally breeding in winter and Carnaby's Cockatoo then utilising a hollow in the same year after ducks or parrots have fledged.

Refer to Figure 9 and Appendix D for the location and details of all 416 trees with DBH >500 mm.

7.4.3.3 Roosting Habitat

Carnaby's Cockatoos typically roost in the tallest trees in the landscape in or near riparian environments or near other permanent water sources. The Forest Red-tailed Black Cockatoo prefers the edges of forests for roosting (DSEWPaC, 2012). Evidence of roosting usually involves large amounts of bird scat beneath a large, mature tree, with a significant amount of broken branches on the ground. Roosting sites were searched for throughout the survey area, but no black cockatoo roost sites were identified.

Multiple Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo roosts have been identified within 12 km of the survey area (BirdLife Australia, 2020a). The closest confirmed BirdLife Australia (2020a) roost to the survey area is VICVICR001, approximately 160 m south. Refer to Figure 10 for locations.

Table 21 Black cockatoo habitat tree details, including species, location, height, diameter, number of potentially suitable hollows, comments and photographs

Id	Species	Coordinates	Tree Height (m)	DBH (cm)	No. of Potentially Suitable Hollows	Hollow Comments	Photographs
67	River Red Gum *Eucalyptus camaldulensis*	115.885720, -31.970333	20	120	1	South facing hollow in fork of tree, approx. 100 mm x100 mm hollow entrance, 6 m above ground. Galahs observed at hollow entrance, with potential chewing around hollow entrance.	 

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0 50 100 150 200
metres

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).Geoscience Australia, Streetpro

LEGEND

- Survey Area
- Area not assessed

Eucalypts with >100mm hollow, internal dimensions not assessed
- River Red Gum

Eucalypts with DBH > 500mm
- Bangalay
- Coastal Moort
- Coral Gum
- Flat Topped Yate
- Flooded Gum
- Introduced
- Marri
- Moort
- Port Lincoln Gum
- Red Ironbark
- River Red Gum
- Rose Gum
- Spotted Gum
- Stag
- Sugar gum
- Swamp Mahogany
- Swamp Mallet
- Tuart
- Wandoo
- Yate
- York Gum

Black Cockatoo Breeding Assessment

MAIN ROADS WA

PSP PEDESTRIAN BRIDGE CAUSEWAY ECOLOGICAL SURVEY

Figure 9

Map Document: P:\606X\60612387\7097_Causeway PSP Bridge PEIA and Associated Works\900_CAD_GIS\920_GIS\02_MXDs\60612387_7097_Causeway PSP Bridge PEIA and Associated Works.aprx (WyattK2)

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7.4.3.4 Foraging Habitat

The survey area contains significant numbers of large mature eucalypts, though there are minimal Marri *Corymbia calophylla*, Jarrah *Eucalyptus marginata* and proteaceous species, and the habitats present generally only provide Negligible to Low Quality habitat for black cockatoos. This is generally due to foraging trees being isolated or being only small stands of trees. As a result, the survey area provides negligible habitat for Carnaby's Cockatoo, and low to negligible quality habitat for the Forest Red-tailed black cockatoo. Foraging habitat present is discussed further in the following sections.

The survey area contains a told of 16.75 ha of Negligible Quality foraging habitat for Carnaby's Cockatoo (Figure 10). This is due to the low amounts (<2%) of potential foraging species present within the survey area (site condition), in conjunction with the lack of evidence of foraging observed during the field surveys, and the moderation of scoring as per the BCE Black Cockatoo Scoring System (Appendix E, Appendix F). The foraging quality assessments are presented in Appendix F.

No foraging evidence attributable to Carnaby's Cockatoo was identified within the survey area.

Table 22 Carnaby's Cockatoo foraging habitat

Foraging Quality	Site Condition	Context	Species Density	Total Score	Within Survey Area (ha)
None	0	0	0	0	82.92
Negligible	1	0	0	1	16.75
				TOTAL	**16.75**

The survey area contains a total of 9.01 ha of Low Quality foraging habitat, and 3.13 ha of Negligible foraging habitat for the Forest Red-tailed Black Cockatoo, which is presented spatially in Figure 11. The foraging quality assessments are presented in Appendix E. The slightly higher score for Forest Red-tailed Black Cockatoo compared to Carnaby's Black Cockatoo is due to the presence of scattered food plants with a projected foliage cover of more than 1% (Appendix E). Note that no foraging evidence attributable to the Forest Red-tailed Black Cockatoo was recorded within the survey area.

Table 23 Forest Red-tailed Black Cockatoo foraging habitat

Foraging Quality	Site Condition	Context	Species Density	Total Score	Within Survey Area (ha)
None	0	0	0	0	87.53
Negligible	1	0	0	1	3.13
Low	2	0	0	2	9.01
				TOTAL	**12.14**

7.4.4 Survey Area Context

The survey area is located within a metropolitan and suburban environment on the SCP, with the associated significant levels of clearing and lack of quality black cockatoo habitat. Giving some context to the black cockatoo habitats discussed above, the local area (12 km radius) does not extend to the darling scarp, and the higher quality black cockatoo habitats that exist there. However, it does contain moderate levels of foraging, breeding and roosting habitat in the form of smaller parks, garden and street trees, with several larger areas containing significant higher quality habitat for black cockatoo species for a metropolitan area. These larger areas, which provide significant foraging, breeding and roosting habitat, include Kings Park (approximately 3.5 km west), Bold Park (approximately eight kilometres west-northwest), and the areas containing native vegetation around the airport (approximately eight kilometres east / north-east).

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0 50 100 150 200
metres

Data sources:

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LEGEND

- Survey Area
- Area not assessed
- BirdLife (2020) Black Cockatoo Roost Sites within 2km of Survey Area

Carnaby's Cockatoo Foraging Habitat

- None
- Negligible

Carnaby's Cockatoo Foraging Habitat

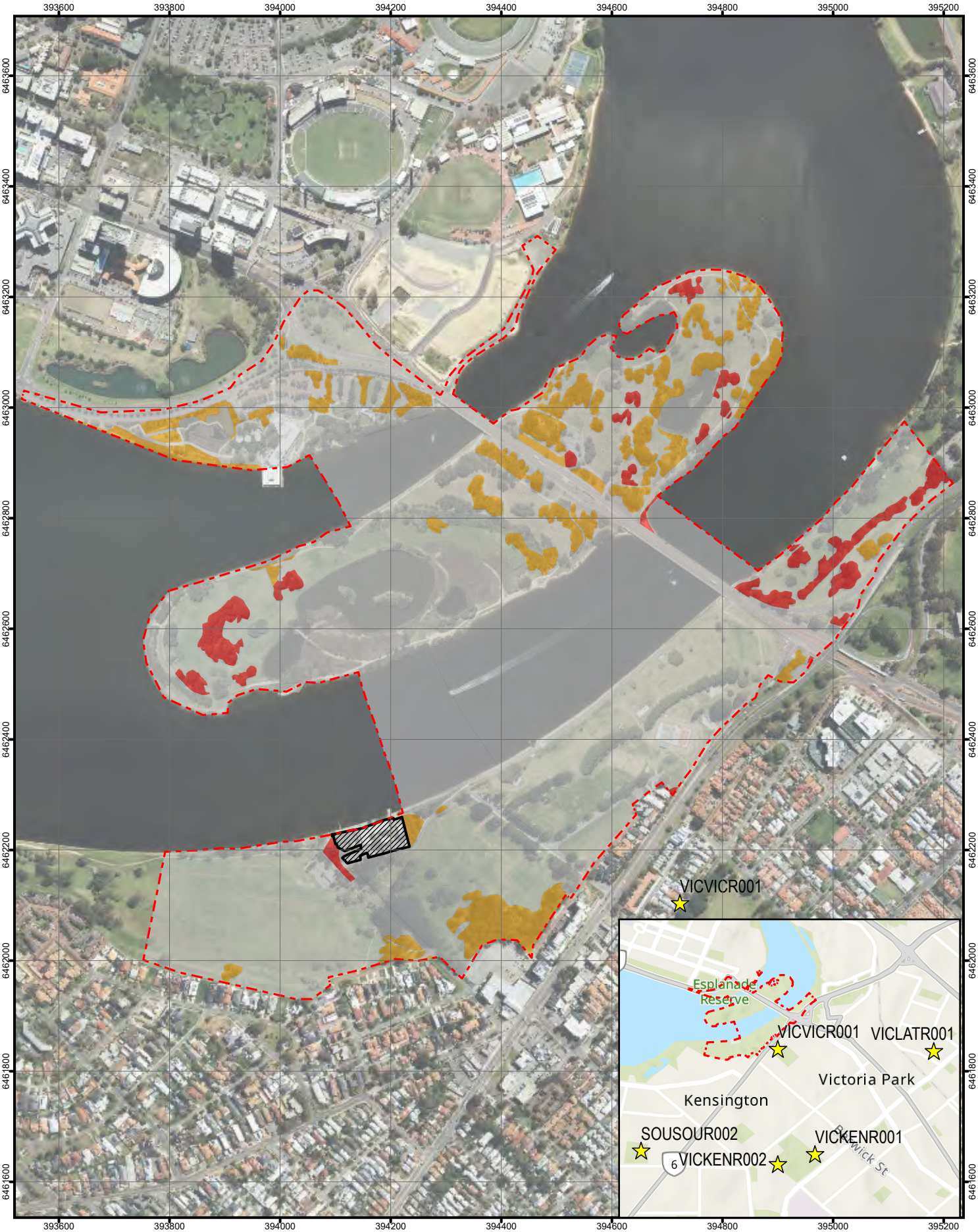
MAIN ROADS WA

PSP PEDESTRIAN BRIDGE CAUSEWAY ECOLOGICAL SURVEY

Figure 10

Map Document: P:\606X\60612387\7097_Causeway PSP Bridge PEIA and Associated Works\900_CAD_GIS\920_GIS\02_MXDs\60612387_7097_Causeway PSP Bridge PEIA and Associated Works.aprx (WyattK2)

A4 size



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metres

Data sources:

Base Data: (c) Based on information provided by and with the permission of the Western Australian Land Information Authority trading as Landgate (2010).Geoscience Australia, Streetpro

LEGEND

- Survey Area
- Area not assessed
- BirdLife (2020) Black Cockatoo Roost Sites within 2km of Survey Area

Forest Red-tailed Black Cockatoo Foraging Habitat

- None
- Negligible
- Low

Forest Red-tailed Black Cockatoo Foraging Habitat

MAIN ROADS WA

PSP PEDESTRIAN BRIDGE CAUSEWAY ECOLOGICAL SURVEY

Figure 11

Map Document: P:\606X\60612387\7097_Causeway PSP Bridge PEIA and Associated Works\900_CAD_GIS\920_GIS\02_MXDs\60612387_7097_Causeway PSP Bridge PEIA and Associated Works.aprx (WyattK2)

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8.0 Conclusions

The biological findings from the assessment of the survey area are:

- Subtropical and Temperate Coastal Saltmarsh TEC (EPBC Act-listed as Vulnerable) / PEC (WA - P3) extends for 3.22 ha, representing 100% of the total area of native vegetation and 3.37% of the total survey area. The TEC was mapped as 'Good' condition.
- The majority of the survey area was mapped as Cleared (61.08 ha, 64%) and Water (18.47 ha, 19%). The remaining 16.05 ha of native vegetation is largely mapped as Completely Degraded (12.39 ha, 13%), Degraded (0.44 ha, 1%) and Good (3.22 ha, 3%).
- The desktop fauna assessment identified 67 significant fauna species had the potential to utilise the survey area, with 10 species that are likely to occur, 26 species that may occur and 31 species that are unlikely to occur. The ten significant species considered as 'likely to occur' are all avian species.
- The survey area has been extensively cleared and modified and three broad fauna habitats were defined and mapped. These comprise Scattered Trees; Wetland, River and Riparian Vegetation; and Parkland and Maintained Gardens. Quality of the habitat varies considerably. These modified and fragmented areas generally only provide habitat for wetland and avian species, and those species which tolerate urbanised environments.
- Thirty-three vertebrate fauna species were recorded during the field survey, comprising 31 bird and two mammal species. A large majority of these species were wetland and waterbird species, with minimal species of conservation significance.
- The survey area was found to contain 416 native and introduced eucalypts with a DBH > 500 mm. Of these, 159 (38%) were River Red Gum *E. camaldulensis*, 146 (35%) were Flooded Gum *E. rudis*, 15 (4%) were Sugar Gum *E. cladocalyx*, and 12 (3%) were Tuart *E. gomphocephala*. The remaining 84 (20%) trees were a mix of native and introduced species. One hollow with a diameter greater than 100 mm, which may potentially be utilised by breeding black cockatoos, was identified in a River Red Gum *E. camaldulensis*.
- Although there are significant numbers of large mature eucalypts within the survey area for a metropolitan area, there are minimal Marri *Corymbia calophylla*, Jarrah *Eucalyptus marginata* and proteaceous species, and the habitats present generally only provide Negligible to Low Quality value foraging habitat for black cockatoos. Approximately 16.75 ha of Negligible value foraging habitat was mapped for Carnaby's Cockatoo *Calyptorhynchus latirostris* and 12.14 ha of Negligible to Low Quality foraging habitat for the Forest Red-tailed Black Cockatoo *Calyptorhynchus banksii naso*.

No limitations that may impact on the ability to assess environmental values of the survey area were identified.

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Appendix A

Desktop Assessment Results

Scientific Name	Common Name	Conservation Status		DBCA		PMST	Ecology	Likelihood of Occurrence
		State	Federal	Last Record	Total Records			
Actitis hypoleucos	Common Sandpiper	IA	Marine / Migratory	-	-	*	The Common Sandpiper is widespread in small numbers throughout Australia, found along all coastlines and in many inland areas (DAWE, 2020). They visit Australia during the non-breeding season. The population when in Australia is concentrated in northern and western Australia (Higgins & Davies, 1996). Areas of national importance within Western Australia include Nuytsland Nature Reserve and Roebuck Bay (Watkins, 1993). The species utilises a wide range of coastal wetlands and some inland wetlands and is mostly found around muddy margins or rocky shores and rarely on mudflats. The Common Sandpiper has been recorded in estuaries and deltas of streams, as well as on banks farther upstream; around lakes, pools, billabongs, reservoirs, dams and claypans, and occasionally piers and jetties (DAWE, 2020).	Likely
Calyptorhynchus banksii subsp. naso	Forest Red-tailed Black Cockatoo	VU	V	21/02/2020	1055	*	The Forest Red-tailed Black Cockatoo is 55-60 cm in length mostly glossy black with a pair of black central tail feathers, a crest, robust bill and bright red, orange or yellow barring in the tail (Higgins, 1999). Males are distinguished by broad red tail panels that are only visible when taking off or alighting (Higgins, 1999). Requires tree hollows to nest and breed, occurs in forests of Karri (*Eucalyptus diversicolor*) , Jarrah (*E. marginata)* and Marri (*Corymbia calophylla*), with flocks moving out onto the Swan Coastal Plain in search of food from exotic trees such as White Cedar (Johnstone *et al*., undated). Foraging habitat for the species consists of Jarrah and Marri woodlands and forest throughout its range. Has become more common in the Metropolitan area in the past few years.	Likely
Calyptorhynchus latirostris	Carnaby's Cockatoo	EN	E	22/08/2019	38160	*	Carnaby's Cockatoo is a white-tailed black cockatoo endemic to the south-west of Western Australia. It is a postnuptial nomad and typically moves west soon after breeding. Breeding occurs mainly from early July to mid-December. There has been an apparent shift in its breeding range further west and south since the middle of last century (Johnstone *et al*., 2010). The species nests in hollows in eucalypts, particularly Salmon Gum (*Eucalyptus salmonophloia*) and Wandoo (*E. Wandoo*), but nests have been found in other eucalypts including York Gum (*E. loxophleba*), Flooded Gum (*E. rudis*), Tuart *(E. gomphocephala*) and Marri (Corymbia calophylla) (Johnstone *et al.* , 2010). Breeding success is largely dependent on suitable feeding habitat adjacent to the nest site to provide the necessary food for the survival of the chick (Johnstone *et al.* , 2010). Diet consists of an array of Proteaceous and Eucalyptus species. Foraging habitat, including Banksia woodlands, is considered to be habitat critical to the survival of the species (Johnstone *et al.* , 2010).	Likely
Charadrius ruficapillus	Red-capped Plover	-	Marine	-	-	*	The Red-capped Plover stands at between 14 cm and 16 cm and occupies most coastal and near coastal environs (Pizzey & Knight, 2007).	Likely
Ardenna carneipes	Flesh-footed Shearwater	VU	Migratory/Marine	14/03/1931	1		The Flesh-footed Shearwater is a large (length 40–47 cm; wingspan 99–107 cm; weight 510–750 g), broad-winged, blackish-brown shearwater with dark brown irides, a pale-horn bill (tipped black) and flesh-pink legs and feet (Enticott & Tipling 1997; Johnstone & Storr 1998; Marchant & Higgins 1990). Pairs breed on 41 islands off the coast of south-western Western Australia (Burbidge & Fuller 1996).	Unlikely
Falco peregrinus	Peregrine Falcon	OS	-	29/07/2014	27		The Peregrine Falcon is a medium-sized raptor (length 35-55cm; wingspan 80-105cm) with slate-grey back, a striking charcoal black head and face which contrast with a pale cream bib on the neck and breast (Birdlife Australia, 2018). A well-known falcon, the Peregrine inhabits a vast array of environs in Australia. Usually uncommon and migratory (Pizzey & Knight, 2007). This species lays its eggs in recesses of cliff faces, tree hollows or large abandoned nests (Bamford, 2009)	Likely
Haliaeetus leucogaster	White-bellied Sea-Eagle	-	Marine / Migratory	-	-	*	The White-bellied Sea-Eagle is a large raptor that has long, broad wings and a short, wedge-shaped tail. It measures 75–85 cm in length, and has a wingspan of 180–220 cm. Females weigh between 2.8 and 4.2 kg, and are larger than the males, which weigh between 2.5 and 3.7 kg (Marchant & Higgins 1993). The White-bellied Sea-Eagle is distributed along the coastline (including offshore islands) of mainland Australia and Tasmania. The White-bellied Sea-Eagle is found in coastal habitats (especially those close to the sea-shore) and around terrestrial wetlands in tropical and temperate regions of mainland Australia and its offshore islands. The habitats occupied by the sea-eagle are characterised by the presence of large areas of open water (larger rivers, swamps, lakes, the sea). Birds have been recorded in (or flying over) a variety of terrestrial habitats (Marchant & Higgins 1993).	Likely
Cacatua pastinator pastinator	Muir's Corella	CD	-	-	1		Muir's Corella is larger in size than the northern subspecies (Ford, 1987). Adults are 43-48 cm in length and 560-815 g in weight (Johnstone and Storr 1998). A medium sized, stocky cockatoo, Muir's Corella has a dull greyish white bill with a long tipped upper mandible (Johnstone and Storr, 1998). The underparts are often stained or dirty (Johnstone and Storr 1998) as a result of feeding on the ground and digging (Higgins, 1999). Muir's Corella is now confined to a small region from Boyup Brook, McAlinden and Qualeup, south to Lake Muir and the lower Perup River, and east to Frankland and Rocky Gully (Storr, 1991; Massam and Long, 1992). It is locally common on farmland, but patchily distributed (Johnstone and Storr 1998).	Unlikely
Himantopus himantopus	Pied Stilt, Black-winged Stilt	-	Marine / Migratory	-	-	*	The Black-winged Stilt is a large black and white wader with long orange-red legs and a straight black bill. It has black on the back of the neck, a white collar and a red iris. Widely distributed across the Australian mainland. Black-winged Stilts prefer freshwater and saltwater marshes, mudflats, and the shallow edges of lakes and rivers. (Birdlife, 2020)	Likely
Calidris alba	Sanderling	-	Marine/Migratory	-	-	*	A small pale wader, reaching 20cm long that breeds in the Northern Hemisphere. This species is almost always found on the coast where they forage in the wave-wash zone and in rotting seaweed (DotE, 2015). This species occurs from the coast near Eyre to Derby, however is more common on the southern and south-west coasts (DotE, 2015).	Unlikely
Hydroprogne caspia	Caspian Tern	MI	Marine	13/04/2016	4		The largest tern in Australia, the Caspian Tern has long, slender backswept wings and a slightly forked tail. The heavy bill is red with a dusky tip. Widespread in coastal regions, from the Great Australian Bight to the Dampier Peninsula. There are sparse records on the coasts east of King Sound and in eastern regions (Higgins & Davies, 1996). The Caspian Tern breeds on variable types of sites including low islands, cays, spits, banks, ridges, beaches of sand or shell, terrestrial wetlands and stony or rocky islets or banks.	Likely
Oxyura australis	Blue-billed Duck	P4	-	16/04/2013	290		The Blue-billed Duck is a compact diving duck with males having a large scooped bright, light blue bill. The tail is dark with stiff pointed feather tips and is usually held flat on the surface of the water except when in display (Birdlife Australia, 2019). The Blue-billed Duck is endemic to south eastern and south western Australia. It prefers deep water in large permanent wetlands and swamps with aquatic vegetation. This species of duck is fully aquatic and rarely comes onto land (OoEH, 2018)	Likely
Pandion haliaetus	Osprey	MI	Marine / Migratory	13/04/2013	3	*	The Eastern Osprey is a medium-sized raptor with dark-brown to blackish-brown above and white below with a white head and neck; a dark-brown to blackish-brown crest; a black stripe across the eye and ear; a band of reddish-brown, brown or dark-brown streaking across the breast. The breeding range of the Osprey includes the northern coast of Australia from Albany in WA to Lake Macquarie in NSW (DotEE, 2019). The Osprey occurs in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and offshore islands. Found mostly in coastal areas but can travel inland along major rivers. Areas of open fresh, brackish or saline water for foraging is essential for their habitat, visiting various wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps and broad rivers, reservoirs and large lakes. They can also occur over atypical habitats such as heath, woodland or forest when travelling between foraging sites.	Likely
Apus pacificus	Fork-tailed Swift	MI	Marine / Migratory	-	-	*	The Fork-tailed Swift is widespread in coastal and subcoastal areas between Augusta and Carnarvon and sparsely scattered inland and along the coast from Augusta to Carnarvon and south-west Pilbara to the north and east Kimberley region. The Fork-tailed Swift is a medium-sized Swift, with a slim body with long scythe-shaped wings that taper to finely pointed tips. It is characterised by a long and deeply forked tail. It is almost exclusively aerial, and a non-breeding visitor to Australia (DotEE, 2018). They mostly occur over inland plains over dry or open habitats, including riparian woodland and tea-tree swamps, low scrub, heathland or saltmarsh but sometimes above foothills or in coastal areas (DotEE, 2018).	May
Ardea ibis	Cattle Egret	MI	Marine / Migratory	-	-	*	The Cattle Egret, Ardea ibis, is a small member of the Ardeidae family. The wingspan and weight vary between sexes; males have a wingspan of 91 cm and weight of 390 g, while the females have a wingspan of 88 cm and weight of 340 g. Length of both sexes is around 70 cm (Marchant & Higgins, 1990). The Cattle Egret occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. It has occasionally been seen in arid and semi-arid regions however this is extremely rare. High numbers have been observed in moist, low-lying poorly drained pastures with an abundance of high grass; it avoids low grass pastures.	May
Ardea modesta	Eastern Great Egret	MI	Marine / Migratory	-	-	*	The Eastern Great Egret is a moderately large bird (83–103 cm in length, 700–1200 g in weight) with white plumage, a black or yellow bill and long reddish and black legs. The species is distributed across Australia and inhabits a wide range of wetland habitats (for example inland and coastal, freshwater and saline, permanent and ephemeral, open and vegetated, large and small, natural and artificial) (Kushlan & Hancock, 2005)	May
Arenaria interpres	Ruddy Turnstone	MI	E	-	-	*	The Ruddy Turnstone is a stocky medium-sized wader with short orange-red legs. The bill is wedge-shaped and slightly up-tilted. The breast is distinctively marked with black or brown and pale areas, almost like tortoise shell, with a white breast.The species is found singly or in small groups along the coastline and only occasionally inland. They are mainly found on exposed rocks or reefs, often with shallow pools, and on beaches. In the north, they are found in a wider range of habitats, including mudflats.	Unlikely

Scientific Name	Common Name	Conservation Status		DBCA		PMST	Ecology	Likelihood of Occurrence
		State	Federal	Last Record	Total Records			
Botaurus poiciloptilus	Australasian Bittern	EN	Marine / Migratory	-	-	*	The Australasian Bittern is a large thick-necked bird, growing to a length of 66 to 76 cm. Upper parts are brown and black and mottled to aid in camouflage. It grows to a length of 66–76 cm and has a wingspan of 1050–1180 cm. The Australasian Bittern has a straw yellow bill and the legs and feet are pale green to olive (Marchant & Higgins, 1990; Pizzey & Knight, 1997). In Western Australia the species was formerly widespread in the south-west however is now thought to only occur on the western coastal plain, southern coastal region and inland to some wetlands in the Jarrah forests (DSEWPaC, 2011). The Australasian Bittern's preferred habitat is comprised of wetlands with tall dense vegetation, where it forages in still, shallow water up to 0.3 m deep, often at the edges of pools or waterways, or from platforms or mats of vegetation over deep water (Marchant & Higgins, 1990).	May
Calidris acuminata	Sharp-tailed Sandpiper	MI	Marine / Migratory	-	-	*	The Sharp-tailed Sandpiper is a small to medium sized wader with a length of 17 to 22 cm and weighing 65g. They are widespread in Western Australia from the Pilbara region to the south-west. They prefer muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation (DotEE, 2018).	May
Calidris canutus	Red Knot, Knot	EN	E	-	-	*	The Red Knot is 23-25cm in length, weighing 120 g. It is robust, short-necked, rather dumpy but long bodied wader with a short straight bill, long wings extending beyond the tail and short legs. It is common in the north-west of Western Australia (Bamford *et al*., 2008). The species mainly inhabits intertidal mudflats, sand flats, in estuaries, bays and lagoons. They are occasionally seen on inland salt lakes and wetlands but hardly every use freshwater swamps.	Unlikely
Calidris ferruginea	Curlew Sandpiper	CR	Marine / Migratory	-	-	*	The Curlew Sandpiper is a small, slim weighing 57 g. In Australia, Curlew Sandpipers occur around the coasts and are also quite widespread inland, though in smaller numbers. In Western Australia, they are widespread around coastal and sub coastal plains from Cape Arid to the south-west Kimberley. Curlew Sandpipers mainly occur on intertidal mudflats in sheltered coastal areas and less often recorded inland around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand.	Unlikely
Calidris melanotos	Pectoral Sandpiper	MI	Marine / Migratory	-	-	*	The Pectoral Sandpiper occupies shallow, fresh waters often containing low grass or other small herbs. It is also observed in swamp margins, flooded pastures and saltmarshes. This species breeds in the northern hemisphere and is a regular though uncommon summer visitor to Australia (Pizzey & Knight, 2007). Rarely recorded in Western Australia (DAWE, 2020).	May
Dasyornis longirostris	Western Bristlebird	EN	E	-	1		The Western Bristlebird is a medium-sized brown, ground dwelling bird standing at 17cm high and weighing between 26-39g (Higgins & Peter, 2002).The Western Bristlebird is restricted to a coastal strip of southern Western Australia from Two Peoples Bay to near East Mount Barren in the eastern end of Fitzgerald River National Park, with a large gap further west of the National Park (DotEE, 2018). The Western Bristlebird is restricted to floristically diverse low dense coastal heathland (McNee, 1986; Smith, 1987).	Unlikely
Calidris ruficollis	Red-necked Stint	MI	Marine / Migratory	-	-	*	The Red-necked Stint is a small Calidridinae approximately 13–16 cm in length and is the smallest shorebird in Australia (Geering *et al*., 2007). It weighs 25 g and has a wingspan between 29 and 33 cm. The species is characterised by a small head, steep rounded forehead, and long thickset body with an attenuated rear end. Other distinguishing features include short legs, a short, straight (or slightly decurved) bill with a slight bulbous or finely pointed tip. Preferred habitat is intertidal mudflats and inland waters (ALA, 2020).	May
Gallinago megala	Swinhoe's Spine	-	Marine / Migratory	-	-	*	Swinhoe's Snipe is a medium sized member of the Gallinagoniae family. It has a length of 27–29 cm, a wingspan of 38–44 cm and a weight of 120 g. The species has a long straight bill, short, broad and somewhat blunt wings, short tail and short legs. During the non-breeding season Swinhoe's Snipe occurs at the edges of wetlands, such as wet paddy fields, swamps and freshwater streams.Habitat specific to Australia includes the dense clumps of grass and rushes round the edges of fresh and brackish wetlands. Rare visitor to Australia, mainly visits northern Australia	Unlikely
Gallinago stenura	Pin-tailed Snipe	-	Marine / Migratory	-	-	*	The Pin-tailed Snipe is a small member of the Gallinago family. It has a length of 25–27 cm, a wingspan of 44–47 cm and an average weight of 115 g. The species has a long straight bill, rather short broad somewhat blunt wings, a very short tail and short legs. During non-breeding period the Pin-tailed Snipe occurs most often in or at the edges of shallow freshwater swamps, ponds and lakes with emergent, sparse to dense cover of grass/sedge or other vegetation. The species is also found in drier, more open wetlands such as claypans in more arid parts of species' range. In Western Australia the species was reported at Pilbara, Port Headland, Myaree Pool, Maitland River and near Karratha. In Pilbarra the distribution is believed to be bound by Pardoo (Banningarra Spring) and the lower Maitland River and Shay Gap. The Pin-tailed Snipe has also been reported on the Cocos-Keeling Islands as well as Christmas Island (Higgins & Davies, 1996).	Unlikely
Calidris tenuirostris	Great Knot	CE	CE	-	-	*	Restricted to coastal habitats around Australia where it is common in the Kimberley and Pilbara (DAWE, 2020). It prefers sheltered coastal habitats with large intertidal mudflats or sandflats (inlets, bays, harbours, estuaries, lagoons) (DAWE, 2020).	May
Calyptorhynchus baudinii	Baudin's Cockatoo	EN	E	13/01/2012	3	*	Baudin's Cockatoo is a large cockatoo that measures 50–57 cm in length, with a wingspan of approximately 110 cm. Mostly dull black in colour, with pale whitish margins on the feathers (Higgins, 1999). Habitat critical to the survival of this species includes forests of Karri (*E. diversicolor*) , Jarrah (*E. marginata*) and Marri (*Corymbia calophylla*) , in areas of 600 mm average rainfall per year. Individuals typically move north through the Perth region from March to May and south through the Perth region from August to October. This species ranges north to Gidgegannup and Hoddy Well and west to the Eastern Strip of the Swan Coastal Plain including West Midland in the north, heading south through Armadale, Byford and south and towards the coast until Lake Clifton where it continues to hug the coastline to east of Albany (Johnstone *et al*., 2010). Breeding has been recorded to the south-west of the area bounded by Leschenault, Collie and Albany (DSEWPaC, 2012), with the most northerly record at Lowden, near Donnybrook (Johnstone & Storr, 1998). Breeding has also been recorded at Serpentine (hills area), and east to Kojonup and near Albany (Johnstone & Kirkby, 2008).	May
Charadrius bicinctus	Double-banded Plover	-	Migratory/Marine	-	-	*	The Double-banded Plover weighs approximately 60 g and has diverse plumage depending on age, gender and time of year. The species occurs in a large variety of aquatic, fresh and saline habitats (DotE, 2015).	May
Charadrius leschenaultii	Greater Sand Plover, Large Sand Plover	VU	Marine / Migratory	-	-	*	The Greater Sand Plover is a medium-sized (length: 22–25 cm; weight 75–100 g) brown-and-white plover. Sexes differ when in breeding plumage, but are inseparable when in non-breeding plumage; juveniles are also separable from adults (Marchant & Higgins, 1993; Stewart *et al*., 2007). In Australia, the Greater Sand Plover occurs in coastal areas in all states, though the greatest numbers occur in northern Australia, especially the north-west (Marchant & Higgins, 1993; Minton *et al*., 2006). In the non-breeding grounds in Australasia, the species is almost entirely coastal, inhabiting littoral and estuarine habitats. They mainly occur on sheltered sandy, shelly or muddy beaches with large intertidal mudflats or sandbanks, as well as sandy estuarine lagoons (Steward *et al*., 2007)	May
Leipoa ocellata	Malleefowl	VU	V	30/11/1981	46	*	The Malleefowl is a large, ground-dwelling bird with strong feet and a short bill. It is found principally in the semi-arid to arid zone in shrublands and low woodlands dominated by mallee and associated habitats such as such as Broombush (*Melaleuca uncinata*) and Scrub Pine (*Callitris verrucosa*).	Unlikely
Charadrius mongolus	Lesser Sand Plover	EN	E	-	-	*	The Lesser Sand Plover occurs in similar habitats to the Greater Sand Plover (DotE, 2015). This species typically feeds from the surface of wet sand or mud on open intertidal flats of sheltered bays, lagoons or estuaries (DotE, 2015).	May
Heteroscelus brevipes	Grey-tailed Tattler	-	Marine/Migratory	-	-	*	This species is typically found in the south-west between Augusta and Cervantes and occupies reefs and rock platforms or intertidal mudflats (Johnstone & Storr, 1998; DotE, 2015).	May
Idiosoma sigillatum	Swan Coastal Plain Shield-backed Trapdoor Spider	VU	V	1/07/2003	25		*Idiosoma sigillatum* has a relatively widespread although strictly bioregion- and substrate-specific distribution along the Swan Coastal Plain of south-western Western Australia, from Dalyellup north to at least Ledge Point (including Rottnest Island and Garden Island). The eastern limit of its range along the sandy foothills of the Darling Escarpment, from Boyanup north to at least Gingin, abuts the western limits of the ranges of *I. jarrah* and *I. mcclementsorum*. *Idiosoma sigillatum* is the dominant idiopid trapdoor spider on the Swan Coastal Plain, with a previously ubiquitous distribution throughout the Greater Perth region, where it can still be found in remnant habitats (e.g., Kings Park, Bold Park, and Shenton Park bushland). Burrows of this species usually occur in Banksia woodland and heathland on sandy soils, and are adorned with a typical 'moustache-like' arrangement of twig-lines (Rix *et al*., 2018).	Unlikely
Numenius madagascariensis	Eastern Curlew	CR	CE	-	-	*	The eastern curlew is Australia's largest shorebird and a long-haul flyer. It is easily recognisable, with its long, down-curved bill (DotEE, 2018).The wingspan is 110 cm and the birds weigh approximately 900 g. The head and neck are dark brown and streaked with darker brown. Within Australia, this bird has a primarily coastal distribution. It is found in all states and has a continuous distribution from Barrow Island through the Kimberley region and into the Northern Territory with more scattered records along the coastlines south (DotEE, 2018).a. In southern Western Australia, eastern curlews are recorded from Eyre, and there are scattered records from Stokes Inlet to Peel Inlet. The species is a scarce visitor to Houtman Abrolhos and the adjacent mainland, and is also recorded around Shark Bay. It is also recorded on Norfolk Island and Lord Howe Island (Marchant & Higgins, 1993).	Unlikely
Numenius minutus	Little Curlew, Little Whimbrel	-	Marine / Migratory	-	-	*	The Little Curlew is the smallest curlew with an average length of 28–31 cm, wingspan of 68–71 cm and weight of 175 g (Birds Australia 2010; Higgins & Davies 1996).Little Curlews generally spend the non-breeding season in northern Australia from Port Hedland in Western Australia to the Queensland coast. When resting during the heat of day, the Little Curlew congregates around pools, river beds and water-filled tidal channels, and shallow water at edges of billabongs. The species prefers pools with bare dry mud (including mudbanks in shallow water) and they do not use pools if they are totally dry, flooded or heavily vegetated (Higgins & Davies 1996). Birds may also rest in grassy, open woodlands and on bare blacksoil plains, or on dry or recently burnt grasslands on floodplains, which may be without vegetation for hundreds of metres, and occasionally on mudflats when nearby grasslands are unburnt, or around swamps. Resting has also been recorded under partly submerged vegetation. After freshwater pools dry up, roosting may occur in the shallows of reservoirs and the sea (Higgins & Davies 1996).	Unlikely
Limosa lapponica	Bar-tailed Godwit	VU	Marine/Migratory	-	-	*	The Bar-tailed Godwit is a large wader weighing up to 450 g and in Western Australia is widespread around the coast from Eyre to Derby (DotE, 2015).	May
Limosa limosa	Black-tailed Godwit	MI	E	-	-	*	The Bar-tailed Godwit is a large wader and member of the Tringinae family. The bird has a length around 37–39 cm, a wingspan of 62–75 cm and a weight between 250–450 g. The bird has a long neck with a very long upturned bill characterized by a dark tip and pinkish base. In Western Australia it is widespread around the coast, from Eyre to Derby, with a few scattered records elsewhere in the Kimberley Division. The Bar-tailed Godwit is found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays. It is found often around beds of seagrass and, sometimes, in nearby saltmarsh.	May

Scientific Name	Common Name	Conservation Status		DBCA		PMST	Ecology	Likelihood of Occurrence
		State	Federal	Last Record	Total Records			
Merops ornatus	Rainbow Bee-eater	MI	Marine / Migratory	-	-	*	The Rainbow Bee-eater is a medium-sized bird, and the only species of bee-eater in Australia. The males measure 25 cm in length and the females 22 cm. Both length measurements include the central tail-streamers, which project 2 - 6 cm beyond the rest of the tail in the male and 1 - 2 cm in the female. The wingspan is 34 cm in the male and 31 cm in the female (Higgins 1999). The extent of occurrence of the Rainbow Bee-eater in Australia has not been estimated. Trends in the extent of occurrence have not been quantified, but records indicate that the distribution of the species (and, hence, the extent of occurrence) has expanded in south-western Australia. The Rainbow Bee-eater was rare around Perth during the 19th century, and was recorded only infrequently before the 1920s. However, the bee-eater had begun to vist Perth regularly and in larger numbers by the late 1970s, and it colonized Rottnest Island in 1977 (Abbott et al. 1978; Storr & Johnstone 1988). The Rainbow Bee-eater occurs mainly in open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation (Higgins 1999). It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water	May
Phalaropus lobatus	Red-necked Phalarope	-	Marine/Migratory	-	-	*	The Red-necked Phalarope is the smallest Phalarope, weighing up to 34 g. It occupies both inland and coastal lakes/swamps, including highly saline waters and artificial wetlands, including commercial salt fields (DotE, 2015). This species has been recorded at several locations in Western Australia (DotE, 2015).	Unlikely
Numenius phaeopus	Whimbrel	-	Marine/Migratory	-	-	*	The Whimbrel occurs all along the Australian coast and inhabits estuaries, mangroves, tidal flats, flooded paddocks, and bare grasslands (Pizzey & Knight, 2007)	May
Pluvialis fulva	Pacific Golden Plover	MI	Marine / Migratory	-	-	*	The Pacific Golden Plover is a medium-sized (length 23–26 cm; weight: 120–175 g) plover with long legs and an upright stance. The species is widespread along the coastline of Australia and inhabits found on muddy, rocky and sandy wetlands, shores, paddocks, saltmarsh, coastal golf courses, estuaries and lagoons.	May
Pluvialis squatarola	Grey Plover	MI	V	-	-	*	The Grey Plover is a medium sized plover, with the Australian population breeding in Siberia between May and August, with individuals reaching the south coast of Australia in October and November (DotE, 2015).	May
Rostratula australis	Australian Painted Snipe	EN	EN / Marine	-	-	*	The Australian Painted Snipe is a stocky wading bird around 220–250 mm in length with a long pinkish bill. The species is occassional found in the south west of Western Australia. The Australian Painted Snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans.	Unlikely
Sterna dougallii	Roseate Tern	IA	Marine/Migratory	-	-	*	The Roseate Tern is a small-medium tern, with a wingspan of 67-76 cm (Higgins & Davies 1996). The Roseate Tern has a slender, pointed, black bill, which develops a red base in the breeding season. The upper wings are grey and the underside is white. Adults have long, flexible tail streamers and orange-red legs (Higgins & Davies, 1996). The Roseate Tern occurs in coastal and marine areas in subtropical and tropical seas. The species inhabits rocky and sandy beaches, coral reefs, sand cays and offshore islands. Birds rarely occur in inshore waters or near the mainland, usually venturing into these areas only accidentally, when nesting islands are nearby (Higgins & Davies, 1996).	Unlikely
Recurvirostra novaehollandiae	Red-necked Avocet	-	Marine	-	-	*	The Red-necked Avocet has a chestnut brown head and neck with a white eye-ring and a long, upturned, black bill. The rest of the body is white, except for two black streaks along the back. The Red-necked Avocet is found throughout mainland Australia, but breeds mainly in the south-western interior. The species inhabits shallow wetland environments.	May
Sternula nereis subsp. nereis	Australian Fairy Tern	VU	V	-	-	*	The Fairy Tern is a small bird weighing approximately 70 g, and is described as bulky and round bodied (Simpson & Day 2004). The breeding plumage of both sexes is pale grey-white, with a black crown, nape, ear coverts and patch in front of the eyes (square to round in shape) (Higgins & Davies 1996). The species is found along coasts of Victoria, Tasmania, South Australia and Western Australia, occuring as far north as the Dampier Archipelago. The Fairy Tern nests on sheltered sandy beaches, spits and banks (DotE, 2015).	May
Thinornis cucullatus	Hooded Plover	P4	Marine	-	-	*	The Hooded Plover is a medium-sized sandy-brown plover. It has a black head and a white nape, and the black hindneck collar extends around and forks onto the breast. West of the Nullarbor Plain, Hooded Plovers are also often recorded on ocean beaches, but they are just as likely to be seen foraging at salt lakes, sometimes hundreds of kilometres from the coast.	Unlikely
Tringa brevipes	Grey-tailed Tattler	-	Marine / Migratory	-	-	*	The Grey-tailed Tattler is a medium sized wader with a primarily coastal northern coastal distribution and found in most coastal regions. In WA, it is found rarely on the south coast and between Augusta and Cervantes. It is more common and widespread from the Houtman Abrolhos and mainland adjacent to the Kimberley Region (DotE, 2015).	Unlikely
Thalasseus bergii	Crested Tern	-	Marine/Migratory	27/01/2013	1		This large tern is predominantly found offshore and coastal, on beaches, bays, inlets, tidal rivers, salt swamps, lakes and larger rivers (Pizzey & Knight, 2010).The Crested Tern is usually a strictly coastal species, though there are occasional records in the arid interior of Australia, where birds were possibly blown by passing tropical cyclones (Birdlife Australia, 2018).	May
Tringa glareola	Wood Sandpiper	MI	Marine / Migratory	-	-	*	The Wood Sandpiper is a small thin wader and member of the Tringinae family. The species has a length of 19–23 cm, a wingspan of 56–57 cm and a weight of 55 g. The species has a short straight bill and long legs. It is similiar in size to the Sharp-tailed Sandpiper. The Wood Sandpiper uses well-vegetated, shallow, freshwater wetlands, such as swamps, billabongs, lakes, pools and waterholes. They are typically associated with emergent, aquatic plants or grass, and dominated by taller fringing vegetation, such as dense stands of rushes or reeds, shrubs, or dead or live trees, especially Melaleuca and River Red Gums Eucalyptus camaldulensis and often with fallen timber. They also frequent inundated grasslands, short herbage or wooded floodplains, where floodwaters are temporary or receding, and irrigated crops. They are also found at some small wetlands only when they are drying. They are rarely found using brackish wetlands, or dry stunted saltmarsh. Typically they do not use coastal flats, but are occasionally recorded in stony wetlands. This species uses artificial wetlands, including open sewage ponds, reservoirs, large farm dams, and bore drains (Higgins & Davies, 1996). In Western Australia, within wetlands, birds often occur within a few metres of one another and are concentrated at a few sites in a wetland (Higgins & Davies, 1996).	May
Tringa nebularia	Common Greenshank	MI	Marine / Migratory	-	-	*	The Common Greenshank is a largely built wader, weighing up to 190 g for both sexes. The species is found in inland wetlands and sheltered coastal habitats (DotE, 2015). The Common Greenshank is generally absent from the Western Deserts although there are a few records from the Great Sandy Desert and the Nullarbor Plain. It occurs around most of the coast from Cape Arid in the south to Carnarvon in the north-west. In the Kimberleys it is recorded in the south-west and the north-east, with isolated records from the Bonaparte Archipelago (Higgins & Davies, 1996).	May
Tringa totanus	Common Redshank	-	Marine / Migratory	-	-	*	The Common Redshank is 27–29 cm long, has a wingspan of 48–55 cm and weighs around 120 g. It is a somewhat dumpy wader, with long orange-red legs and a straight, medium-length bill with a reddish base. The Common Redshank is found at sheltered coastal wetlands such as bays, river estuaries, lagoons, inlets and saltmarsh (with bare open flats and banks of mud or sand).	May
Calidris subminuta	Long-toed Stint	MI	V	1/04/1991	1		The Long-toed Stint is a very small sandpiper and member of the Calidridinae family. The species has a length of 13–16 cm, a wingspan of 26.5–30.5 cm and an average weight of 25 g. The species is characterised by its distinctive shape; a small head, long slim neck, rounded belly, short rear-end, long legs (often held flexed), short straight bill tapering to finely pointed tip, folded primaries that fall level with the tail and show little or no primary projection beyond the tertials (Higgins & Davies 1996). In Western Australia the species is found mainly along the coast, with a few scattered inland records. On the south coast the Long-toed Stint is found from Esperance to Albany and inland to Lake Cassencarry and Dumbleyung. On the south-west coast the species is known from the Vasse River estuary, Guraga Lake and the Nanming Nature Reserve. It is distributed along most of the Australian coastline with large densities on the Victorian and Tasmanian coasts. The Red-necked Stint has been recorded in all coastal regions, and found inland in all states when conditions are suitable.	Unlikely
Euoplos inornatus	Inornate Trapdoor Spider (northern Jarrah Forest)	P3	-	21/12/1998	16		Euoplos is a spider genus in the family Idiopidae which is found in various geographical locations in Australia. The trapdoor spider species Euoplos inornatus occurs on the eastern edge of the SCP, although most records are from the Darling Scarp and the jarrah forest to the east (Invertebrate Solutions, 2018).	Unlikely
Xenus cinereus	Terek Sandpiper	IA	Marine/Migratory	-	-	*	The Terek Sandpiper has a primarily coastal distribution with some records inland and is more common in northern and eastern Australia than southern Australia. It has been recorded between Bunbury and the mouth of the Moore River (DotE, 2015).	May
Synemon gratiosa	Graceful Sun Moth	P4	-	-	1		The Graceful Sun Moth occurs throughout the Swan Coastal Plain and extends north into the Geraldton Sandplain (DEC, 2011). It is associated with two habitat types: 1. Coastal heathland on Quindalup dunes where it is restricted to secondary sand dunes due to the abundance of the preferred host plant *Lomandra maritima* . The Graceful Sun Moth is recorded at substantially higher rates on the L. maritima habitat and is therefore more numerous/dense in this coastal habitat (DEC 2011). 2. Banksia woodland on Spearwood and Bassendean dunes, where the second known host plant *L. hermaphrodita* is widespread. The relative contribution of the Banksia woodland (*L. hermaphrodita*) habitat to the total population and area of occupied habitat of the Graceful Sun Moth is small (DEC 2011). Dispersal is thought to be limited by fragmentation of habitat (DEC, 2011). Recent discoveries have resulted in this species being downgraded to P4 (DEC, 2012a).	Unlikely
Westralunio carteri	Carter's Freshwater Mussel	VU	V	13/05/1905	2		The only reasonably large bivalve in freshwaters of south-west Western Australia. Occurs in greatest abundance in slower flowing waters with stable sediments that are soft enough for burrowing. Salinity tolerance is quite low (>3 g /L is lethal) (Klunzinger *et al.*, 2012).	Unlikely

Scientific Name	Common Name	Conservation Status		DBCA		PMST	Ecology	Likelihood of Occurrence
		State	Federal	Last Record	Total Records			
Hydromys chrysogaster	Water Rat	P4	-	18/10/2019	2		The Water Rat is one of the few Australian mammals adapted to the aquatic environment. It has a streamlined body and broad, partially webbed hind feet. The species occurs in the vicinity of permanent bodies of fresh or brackish water. Dens are made at the end of tunnels in banks and occasionally in logs (Van Dyck & Strahan, 2008).	Unlikely
Macrotis lagotis	Greater Bilby	VU	V	-	1		The greater bilby is a medium-sized burrowing marsupial that lives in the desert. It occurs in a number of disjunct locations between south-west Queensland and the Pilbara. It has a long tail, very big ears and silky soft fur. It is a solitary species that shelters during the day in a burrow	Unlikely
Pseudocheirus occidentalis	Western Ringtail Possum	CE	CE	-	-	*	This species is restricted to the south-west corner of Western Australia. Closer to the coast it is closely associated with Peppermint (*Agonis flexuosa*) forest and woodland and Tuart (*Eucalyptus gomphocephala*) with a peppermint mid-story. Further from the coast the species is found in Jarrah (*Eucalyptus marginata*), Wandoo (*Eucalyptus wandoo*) and Marri (*Corymbia calophylla*) forest (Van Dyck & Strahan, 2008).	Unlikely
Bettongia penicillata subsp. ogilbyi	Woylie	CE	E	-	-	*	The woylie (*Bettongia penicillata ogilbyi*) is a small native marsupial 1-1.5 kg in weight. Head and body length is 280-360mm and tail length is between 290-360mm. The woylie distribution is concentrated in the south west of Western Australia however there are also translocated populations reaching as far north as Shark Bay and as far east as the New South Wales and South Australian border. The last four remaining indigenous populations are all in south west Western Australia (Mawson 2004; Pacioni 2010; Pacioni *et al.* 2010). These are Perup, Kingston, Dryandra woodland and Tutanning nature reserve. The current habitat includes tall eucalypt forest and woodland, dense myrtaceous shrubland, kwongan (proteaceous) or mallee heath (Yeatman & Groom, 2012). Thickets and other suitable habitat types such as heath, provide refuges for woylies against predators	Unlikely
Dasyurus geoffroii	Western Quoll, Chuditch	VU	V	25/06/1969	9	*	At maturity the Chuditch is the size of a small domestic cat with white spotted brown pelage, large rounded ears, pointed muzzle, large dark eyes and non-hopping gait. The Chuditch requires adequate numbers of suitable den and refuge sites (horizontal hollow logs or earth burrows where they mostly rest during the day) and sufficient prey biomass (large invertebrates, reptiles and small mammals) to survive. It primarily forages on the ground at night, although can be active during the day during the breeding season or during bad weather. It may eat any animal smaller than a rabbit and they can climb trees when hunting or escaping predators. The chuditch previously occurred throughout arid and semi arid Australia, but is now restricted to south-west Western Australia. It currently only occurs in areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland (Van Dyck & Strahan, 2008).	Unlikely
Myrmecobius fasciatus	Numbat	EN	-	-	3		The numbat is diurnal (active during the day) and feeds almost exclusively on termites which it obtains by uncovering galleries on the forest floor. It nests in hollow logs, tree hollows or in burrows. Previously widespread in arid and semi-arid Australia, the species is now restricted to two isolated wild populations in south-west Western Australia and a number of translocations to predator proof locations (DPaW, 2015).	Unlikely
Notamacropus irma	Western Brush Wallaby	P4	-	21/02/1975	2		The Western Brush-wallaby occurs in the south-west of Western Australia. Its preferred habitat consists of open sclerophyll forest or woodland and favours open flats over scrub thickets. However, it doesn't seem to venture into open pasture areas adjacent it's bushland refuges. It is also found in larger areas of mallee and heathland in the wheat belt and is uncommon in wet sclerophyll forest (Van Dyck & Strahan 2008). Three most commonly consumed species are *Cynodon dactyol*, *Nuytsia floribunda* and *Carpobrotus edulis* (DEC, 2007).	Unlikely
Phascogale tapoatafa subsp. wambenger	South-western Brush-tailed Phascogale, Wambenger	CD	-	9/01/2017	3		The Brush-tailed Phascogale is one of the most arboreal dasyurids and rarely feeds on the ground. The species is distinguished by a large black tail. The species formerly occupied all the dry sclerophyll forests and woodlands of temperate and tropical Australia. The species suffered a drastic reduction in habitat due to clearing of prime habitat for agriculture and now prefers open forest with sparse groundcover. It has been observed in habitats ranging from mallee to rainforest.	Unlikely
Lerista lineata	Perth Slider	P3	-	8/06/1977	12		The Perth Lined Lerista is an underground dwelling skink, sheltering in leaf litter and upper layers of loose soil. It is typically found at the bases of shrubs, spoil heaps and stick ant nests (Bush *et al.* , 2010). The species inhabits sandy soils supporting Eucalypt/Banksia woodland, coastal heath and low shrubland (Bush *et al.* , 2010; Wilson and Swan, 2010). There are no records of this species north of the Swan River on the Swan Coastal Plain (South Metro Connect, 2011).	Unlikely

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Species	EPBC	State	Habitat	Count date	Likelihood
Acacia anomala	V	VU	Species grows in lateritic soils on slopes. Found in the SCP and Jarrah Forrest IBRA regions.		Unlikey
Acacia benthamii		P2	Found in sand, typically on limestone breakaways. Located in the SCP IBRA region.	1905	Unlikey
Acacia denticulosa	V	VU	Grows in shallow sandy soils, loams or clay. May be found on granite hills and outcrops. Known to the Avon Wheatbelt and Coolgardie IBRA regions.	1984	Unlikey
Acacia horridula		P3	Occurs in the Jarrah Forrest and SCP IBRA regions, on gravelly soils over granite. Sometimes found on rocky hillsides.	1839	Unlikey
Adenanthos cygnorum subsp. *chamaephyton*		P3	This shrub is found on grey sand or lateritic gravel, within multiple IBRA regions in the Southwest Province.	1984	Unlikey
Andersonia gracilis	E	VU	Typically grows in white or grey sand, sandy clay or gravelly loam. May also be found in winter wet areas.	1991	Unlikey
Angianthus micropodioides		P3	Occurs on saline sandy soils, typically near river edges, saline depressions and claypans. Found in the Eremaean and the South-West Province.	1994	Likely (Coastal Saltmarsh TEC species)
Anigozanthos viridis subsp. *Terraspectans*	V	VU	The species is associated with winter-wet depressions on sandy clay loam or grey sand. Species is known from populations west of Cataby.		Unlikey
Aponogeton hexatepalus		P4	Freshwater species, found in ponds, rivers and claypans in the Jarrah Forest and SCP IBRA regions.	2004	Unlikey
Austrostipa bronwenae	E	EN	Species is known from three populations south-east and south of Perth. These were found in winter-wet grey brown sand, sandy loam or dark brown loam over clay. Species has occurred within the Muchea Limestone TEC (DPaW 2017).		Unlikey
Austrostipa mundula		P3	Associated with grassland, heathland and shrubland, in sandy to clay loam soils (PGV 2016).	2016	Unlikey
Babingtonia urbana		P3	Species occurs on laterites, sand and/or winter-wet depressions. Eleven species are known from locations north of Geraldton, Dunsborough and Mount Barker area (Rye 2015).	1948	Unlikey
Banksia mimica	E	VU	Species grows on grey or white sand or loam in open woodlands, on flat to gentle slopes.		Unlikey
Banksia pteridifolia subsp. *vernalis*		P3	Typically grows in white or grey sand over laterites, distributed throughout the Geraldton Sandplains, Jarrah Forrest and SCP IBRA regions.	1992	Unlikey
Beyeria cinerea subsp. *cinerea*		P3	Species has been recorded in brown/orange sand on limestone ridges near Yanchep. Typically found in upper slopes and ridges (Mattiske 2014).	2002	Unlikey
Bolboschoenus fluviatilis		P1	Grows in shallow water, typically on edges of lakes and open swamps in the SCP.	2018	May occur
Boronia tenuis		P4	Occurs in the Jarrah Forrest and SCP IBRA regions, on laterite, stony soils and granite.	1967	Unlikey
Byblis gigantea		P3	Found in sandy-peat swamps, typically in seasonally wet areas. Species located in the Jarrah Forrest and SCP IBRA regions.	2001	May occur
Caladenia huegelii	E	CR	Grows in deep grey or white sand (Bassendean sand-dune system). Typically found in mixed jarrah woodland (DEC 2008).	2012	Unlikey
Calectasia grandiflora		P2	Located in the SCP region, species grows in a variety of soils including white, grey or yellow sand, sandy-clay, gravel, laterite and granite. Typically occurs in swampy area, rock outcrops, flats, slopes and ridges.	1983	Unlikey
Calothamnus graniticus subsp. *leptophyllus*		P4	Occurs on clay over granite and lateritic soils on hillsides, within the Jarrah Forest and SCP regions.	2006	Unlikey

Species	EPBC	State	Habitat	Count date	Likelihood
Calothamnus macrocarpus		P2	Species grows in rocky quartzite soils or sand, typically on slopes. Known to the Esperance Plains and SCP IBRA regions.	2006	Unlikey
Calytrix breviseta subsp. *breviseta*	E	CR	Species typically confined to the Kenwick area, although has historical recordings at Gosnells and Bellevue. Grows in sandy clay on swampy flats.		May occur
Carex tereticaulis		P3	This grass occurs in the Jarrah Forest, SCP and Warren IBRA regions, typically on black peaty sand.	2004	Unlikely
Chamelaucium floriferum subsp. *diffusum*		P2	Species grows in grey sand or shallow loam, found on granite hills and outcrops.	2001	Unlikey
Chamelaucium lullfitzii N.G.Marchant (Current name) *Chamelaucium* sp. Gingin (N.G.Marchant 6) - name on sprat	E	VU	Shrub is confined to the Gingin/Chittering area, and is found on white or yellow sand, in low open woodland.		Unlikley
Conospermum undulatum	V	VU	Shrub is located within the Jarrah Forest and SCP IBRA regions, found in grey or yellow/orange clayey sand.	2010	Unlikley
Conostylis bracteata		P3	Occurs in sand dunes, on sand or limestone soils. Species distributed in the SCP IBRA region.		Unlikley
Cyathochaeta teretifolia		P3	Species grows along swamps and creek edges, and typically found in grey sand or sandy clay.	2008	Unlikley
Dampiera triloba		P3	Specimens collected from Gnangara, Cunderdin, Avon Valley and Bayswater.	1900	Unlikey
Dicrastylis micrantha		P3	Distributed throughout the Eremaean and South-West Provinces, typically found in Edel, Geraldton Hills and Perth. Grows in red sand, on sandplains.	2002	Unlikey
Dillwynia dillwynioides		P3	Species grows in sandy soils, within winter-wet depressions, in the SCP IBRA region.	1974	Unlikey
Diplolaena andrewsii	E	EN	Occurs in the loam and clay soils, on granite outcrops and hillsides. Typically found in the Darling Scarp.		Unlikey
Diuris drummondii	V	VU	Species is known from 12 populations, between Perth and Walpole. Found in low-lying depressions, in peaty and sandy clay swamps. Often found in wet areas, even during the summer months.		May occur
Diuris micrantha	V	VU	Species often found in winter-wet depressions or swamps, on dark grey/black sandy clay-loam substrates.		May occur
Diuris purdiei	E	EN	Species distributed from Perth south to the Whicher range, often found in sandy clay soils. Typically grows amongst native sedges and dense heath.	1969	Unlikey
Dodonaea hackettiana		P4	Scrub or tree, found in sand on outcropping limestone. Occurs in the SCP IBRA region.	2003	Unlikey
Drakaea elastica	E	CR	The species is known to occur between Cataby to Busselton, growing sand within winter wet swamps. Typically surrounded by Banksia woodland or thicket.		Unlikey
Drakaea micrantha	V	EN	Species often found in open sandy patches or fire breaks, on infertile grey sand. Typically surrounded by Banksia, Jarrah and Common sheoak.		Unlikey
Drosera occidentalis		P4	Perennial herb located in the Jarrah Forest and SCP IBRA regions.	1994	Unlikey
Eleocharis keigheryi	V	VU	Known populations are fragmented and have been found North of Eneabba and south-east Qualeup. Species occurred in clay or sandy loam, on freshwater creeks or claypans.	2001	Unlikey
Eremophila glabra subsp. *chlorella*	E	EN	Species occurs in low open heath, on winter-wet depressions. Found in grey-brown sand over clay based sub-soils. Known to occur in the Muchea Limestone at Cannington; and Corymbia calophylla-Kingia australis woodlands TECs.	2011	Unlikey

Species	EPBC	State	Habitat	Count date	Likelihood
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)		P3	Species is distributed in the SCP bioregion.	1989	Unlikey
Eryngium sp. *Subdecumbens* (G.J. Keighery 5390)		P3	Species is distributed in the SCP bioregion. Occurs in the Clay pans of the SCP TEC.	1982	Unlikey
Eucalyptus caesia subsp. *caesia*		P4	Mallee is located in the Eremaean and South-west provinces, growing in loam on granite outcrops.	1984	Unlikey
Eucalyptus caesia subsp. *magna*		P4	Located in the Eremaean and South-west provinces, growing in loam on granite outcrops.	1984	Unlikey
Eucalyptus educta		P2	Occurs on shallow soils on granite rocks, distributed in the Eremaean and South-West Province.	2008	Unlikey
Eucalyptus kruseana		P4	Grows in sandy loam on granite outcrops and hills, located in the Coolgardie and SCP IBRA regions.	1984	Unlikey
Eucalyptus rhodantha var. *rhodantha*		T	Species is known from populations in the northern wheatbelt, growing in sandy or sandy loam soils, often with gravel. Typically found in flat or undulating country or hillslopes.	1984	Unlikey
Eucalyptus x *balanites*	E	CR	Typically found within gently sloping heathlands, open mallee woodland over shrubland or heathland with emergent mallees. Generally on light coloured sandy soils over laterite.		Unlikey
Eucalyptus x *mundijongensis*		P1	Recorded in the SCP IBRA region, on loam soils and in paddocks.	2016	Unlikey
Fabronia hampeana		P2	Occurs in the South-west Province in the Esperance Plains, Geraldton Sandplains and SCP IBRA regions.	1984	Unlikey
Grevillea curviloba subsp. *incurva*	E	EN	Typically is found on open heath in winter-wet areas on sand over limestone, or over ironstone. Species have also been found on road and rail reserves. Species occurs in two TECs the Shrublands and Woodlands on Perth to Gingin Ironstone; and the Shrublands and Woodlands on Muchea Limestone of the SCP.	1974	Unlikey
Grevillea manglesii subsp. *ornithopoda*		P2	Distributed the in the Jarrah Forest and SCP bioregions.		Unlikey
Grevillea pimeleoides		P4	Found in rocky hillsides, on gravelly soils over granite. Species occurs in the Jarrah Forest and SCP IBRA regions.	1975	Unlikey
Grevillea thelemanniana	CE	CR	Species associated with limestone soils or sandy clay soils, typically in flat winter-wet damp lands. Species has been recorded on the edges of firebreaks and disturbed sites.	1985	Unlikey
Haloragis scoparia		P1	Perennial herb located in the SCP IBRA region.	1901	Unlikey
Hibbertia leptotheca		P3	Species distributed in the SCP IBRA region.	1975	Unlikey
Hydrocotyle lemnoides		P4	Aquatic or floating annual herb, growing in swamps. Distributed throughout the South-West province.	1993	Unlikey
Hydrocotyle striata		P1	Found in springs, grows on clay. The herb is located in the Jarrah Forest and SCP IBRA regions.	1970	Unlikey
Hypolaena robusta		P4	Species grows in white sand, on sandplains. Located in the South-west province.	1935	Unlikey
Isopogon autumnalis		P3	Species distributed in the Geraldton Sandplains, Jarrah Forest and SCP IBRA regions.	1992	Unlikey
Jacksonia sericea		P4	Grows in calcareous and sandy soils, in the SCP IBRA region.	2015	Unlikey
Johnsonia pubescens subsp. *cygnorum*		P2	Occurs in grey, white and/or yellow sand on flats and seasonally wet sites in the SCP.	2012	Unlikey
Lasiopetalum bracteatum		P4	Grows in sandy clay, clay and lateritic gravel. Species found along drainage lines, creeks, gullies and granite outcrops in the Jarrah Forest and SCP IBRA region.	1993	Unlikey
Lasiopetalum glutinosum subsp. *glutinosum*		P3	Species is generally found near Perth, in open woodland or low scrub over heath on slopes of lateritic gravel. Grows in clay or sandy loam near granite outcrops and creek lines.	1924	Unlikey

Species	EPBC	State	Habitat	Count date	Likelihood
Lasiopetalum membranaceum		P3	Species is distributed in the Jarrah Forest, SCP and Warren IBRA regions, found in sand over limestone.	2003	Unlikey
Lepidium pseudohyssopifolium		P1	Grows in swampy ground on the SCP.	1902	Unlikey
Lepidosperma rostratum	E		Distributed in the SCP IBRA region in peaty sand or clay.		Unlikey
Levenhookia preissii		P1	Distributed in the SCP IBRA region in grey or black peaty sand and swamps.	1994	Unlikey
Macarthuria keigheryi	E	EN	Five of the six recorded populations are from the Welshpool, Kewdale and Perth metropolitan areas, the other was recorded in Cooljarloo. Species typically found in low-lying winter-wet areas, on grey or white sands. Species grows in open patches with low tree canopy cover.	2014	May occur
Melaleuca viminalis		P2	Species has been recorded in the South-West and the Northern province of Western Australia.	2006	Unlikley
Ornduffia submersa		P4	Species distributed in the South-West province, occurring in the Avon Wheatbelt, Esperance Plains, Jarrah Forest, SCP and Warren.	1995	Unlikey
Picris compacta		X	Species presumed extinct. Found in loam or limestone on riverbanks.	1941	Unlikey
Platysace ramosissima		P3	Perennial herb, found in sandy soils in the Geraldton Sandplains, Jarrah Forest and SCP IBRA regions.	2006	Unlikey
Poranthera moorokatta		P2	Species is known in only two locations, one in Kings Park and the other in Ellenbrook. These were recorded on white silica sand in open spaces between shrubs (Kings Park) and in shallow damp land on grey and white sand (Ellenbrook) (Barrett 2012).	2005	Unlikey
Ptilotus pyramidatus	CE	CR	Species is only known to occur in the Greater Brixton Street Wetlands. Found in grey, muddy sand on flat plains.		Unlikey

Species	EPBC	State	Habitat	Count date	Likelihood
Ptilotus sericostachyus subsp. *roseus*		P1	Species considered likely to be extinct, last collected in 1906 (Davis & Tauss 2011). Species recorded in the SCP.	1906	Unlikey
Schoenus benthamii		P3	Located in the Jarrah Forest and SCP, and is found in white or grey sand, or sandy clay. Found in winter-wet flats and swamps.	1968	Unlikey
Schoenus capillifolius		P3	Species grows in brown mud on claypans, located in the Avon Wheatbelt, Jarrah Forest and SCP.	1983	Unlikey
Schoenus natans		P4	Aquatic annual, grows in winter-wet depressions throughout the South-West province.	2004	May occur
Schoenus pennisetis		P3	Annual species, grows on grey or peaty sand or sandy clay on swamps and winter-wet depressions.	2007	May occur
Schoenus sp. Waroona (G.J. Keighery 12235)		P3	Species grows in clay or sandy clay on winter-wet flats, in the SCP IBRA region.	1989	Unlikey
Stylidium aceratum		P3	Species grows in sandy soils on swamp heathland on the Geraldton Sandplains, Jarrah Forest and SCP.	1989	Unlikey
Stylidium longitubum		P4	Found in sandy clay or clay, often on seasonal wetlands. Located in the Geraldton Sandplains, Jarrah Forest and SCP IBRA regions.	2012	May occur
Stylidium maritimum		P3	Grows in sand over limestone, on dune slopes and flats. Species association with heath, shrublands and open Banksia woodland.	1987	Unlikey
Stylidium paludicola		P3	Occurs on peaty sand over clay in winter-wet habitats. Associated with Marri and Melaleuca woodland and Melaleuca shrubland.	1999	Unlikey
Synaphea sp. Fairbridge Farm (D. Papenfus 696)	CE	CR	Species is endemic to the Pinjarra Plain and is known from five subpopulations from Serpentine to Dardanup. Occurs on grey, clayey sand with lateritic pebbles, on low woodland areas near winter flats.		Unlikey
Synaphea sp. Pinjarra Plain (A.S. George 17182)	E	EN	Located in the Pinjarra Plain, species predominantly grows on flat grey-brown sandy loam. Species has been recorded in heavier brown clay-sand over laterite pebbles. Often on the boundaries of seasonal wetlands.		Unlikey
Tetraria australiensis	V	VU	Known populations are isolated and fragmented in the Perth and South West Capes in Western Australia. Species occurs in grey sand over clay, particularly in winter-wet, swampy depressions, drainage lines or swamps.	1898	Unlikey
Thelymitra dedmaniarum	E	CR	Species favours red-brown sandy loam soil, with dolerite and granite outcrops.		Unlikey
Thelymitra stellata	E	EN	Occurs in gravelly loam associated with low heath and scrub and low heath on lateritic hill tops.		Unlikey
Thelymitra variegata		P2	Species grows in sandy clay, sand and laterite, in the Jarrah Forest and SCP IBRA region.	1948	Unlikey
Thysanotus anceps		P3	Favours white or grey sand, lateritic gravel or laterite. Located in the Geraldton Sandplains, Jarrah Forest and SCP.	1993	Unlikey
Thysanotus sp. Badgingarra (E.A. Griffin 2511)		P2	Species occurs on grey sand with lateritic gravel, distributed throughout the Eremaean and South-West provinces.	2014	Unlikey
Trithuria occidentalis (Hydatella dioica)	E		One population is known from the Ellenbrook area, growing partly submerged on the edge of shallow, winter-wet claypans in spare shrubland.		Unlikey
Typhonium peltandroides		P1	Species favours shallow sand amongst rough sandstone or clay. Often occurs in slides of gorges, vine thickets, rocky sites or along watercourses.	1999	Unlikey
Verticordia lindleyi subsp. *lindleyi*		P4	Located in the Geraldton Sandplains, Jarrah Forest and SCP IBRA regions, the species grows in sand or sandy clay in winter-wet depressions.	2007	Unlikey

Note:

Species	EPBC	State	Habitat	Count date	Likelihood

The West Australian conservation codes are derived from the *Western Australian Biodiversity Act, 2016*: CR Critically Endangered, EN Endangered, VU Vulnerable, EX Presumed Extinct. Priority Species Department of Biodiversity, Conservation and Attractions Priority Species List: Priority 1, P2, P3, P4, P5

The Australian Commonwealth conservation codes are derived from the *Environment Protection and Biodiversity Conservation Act, 1999*: EX Extinct, E Endangered, VU Vulnerable, M Migratory
The habitat descriptions are obtained from Florabase (WAH, 1998) unless otherwise stipulated.

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Appendix B

Flora Species by Family and Communities Matrix

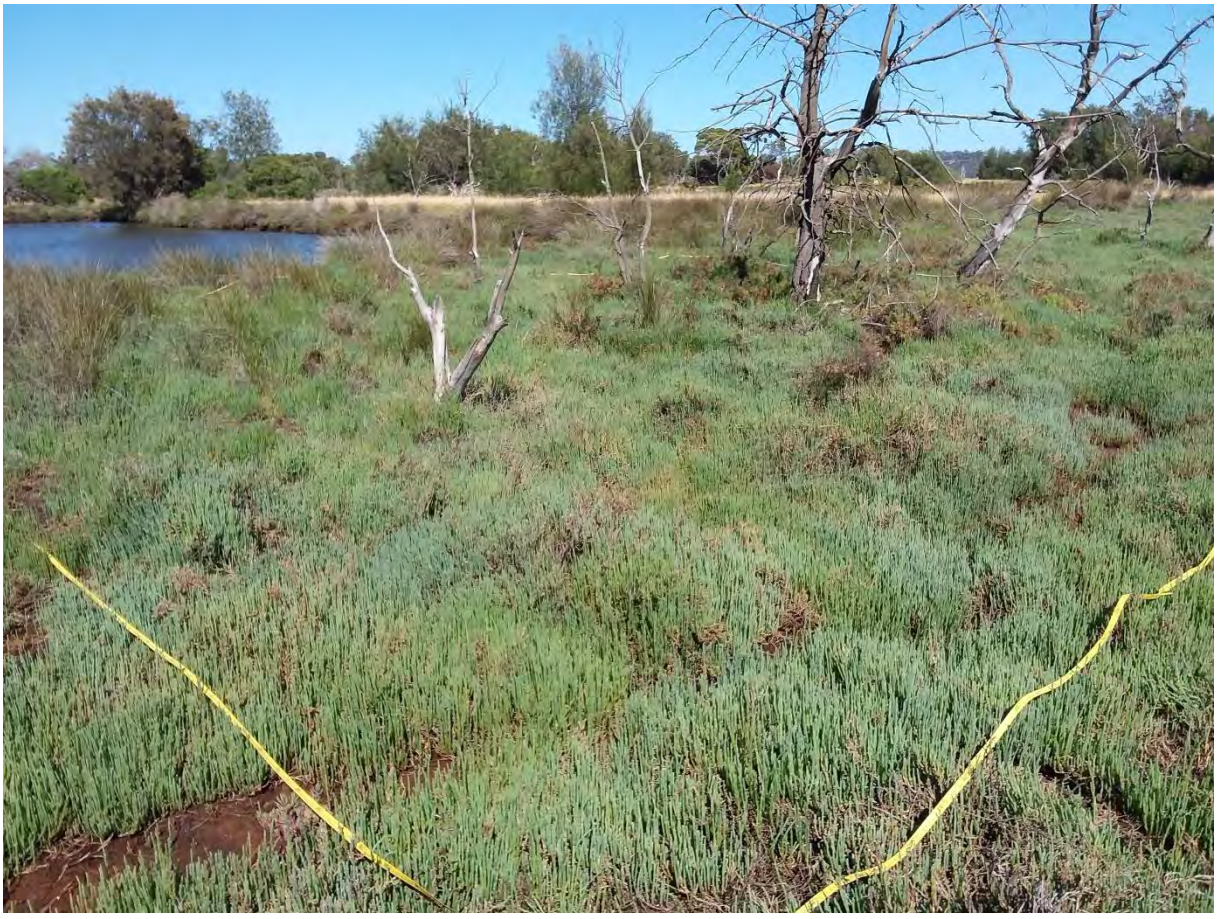
Family		Taxon	Community	
			CoSq	All Other Vegetation Communities
Asteraceae				
	*	*Cotula turbinata*	x	
Casuarinaceae				
	*	*Casuarina cunninghamiana subsp. cunninghamiana*		
		Casuarina obesa	x	x
Chenopodiaceae				
	*	*Atriplex prostrata*	x	x
	*	*Chenopodium glaucum*		
		Rhagodia baccata		
		Salicornia quinqueflora/blackiana	x	x
		Suaeda australis	x	x
		Tecticornia indica subsp. bidens	x	
		Threlkeldia diffusa		
Cyperaceae				
		Baumea juncea		
		Cyperus gymnocaulos		
		Ficinia nodosa		
Fabaceae				
		Melilotus indicus		
Juncaceae				
		Juncus kraussii subsp. australiensis	x	x
		Juncus pallidus		
Myrtaceae				
		Agonis flexuosa		
		Eucalyptus camaldulensis		
		Eucalyptus cladocalyx		
		Eucalyptus rudis		
		Eucalyptus ?sargentii		x
		Eucalyptus suggrandis subsp. suggrandis		x
		Melaleuca lanceolata		
		Melaleuca nesophila		
	*	*Melaleuca quinquenervia*		
		Melaleuca rhaphiopylla		
		Melaleuca viminalis		
Poaceae				
	*	*Hordeum leporinum*		x
	*	*Lolium rigidum*		
Note: * depicts an introduced species				

Appendix C

Quadrat Data

Appendix C Quadrat Data

Site: 1	**Location:** -31.966981 115.881876	**Date:** 5-11-2020
Type: Quadrat	**Size:** 10X10	**Community:** CoSq
Topography: Low flat	**Soils:** Sand	**Colour:** Brown
Litter: none	**Fire:** 10+ years	
Vegetation significance: Subtropical and Temperate Coastal Saltmarsh TEC (EPBC Act-listed Vulnerable)		
Condition: Good		



*	Taxon	Height (cm)	Foliage (%)
	Salicornia quinqueflora/S. blackiana	30	90
	Suaeda australis	50	3
	Juncus kraussii subsp. australiensis	80	5
*	*Cotula turbinata*	5	0.5

Note: * depicts an introduced species

Site: 2	**Location:** -31.967637 115.880621	**Date:** 5-11-2020
Type: Quadrat	**Size:** 10X10	**Community:** CoSq
Topography: Low flat	**Soils:** Sand	**Colour:** Brown
Litter: 5%	**Fire:** 10+ years	
Vegetation significance: Subtropical and Temperate Coastal Saltmarsh TEC (EPBC Act-listed Vulnerable)		
Condition: Good		

*	Taxon	Height cm	Foliage %
	Salicornia quinqueflora/S. blackiana	30	80
	Suaeda australis	50	5
	Juncus kraussii subsp. australiensis	80	10
	Casuarina obesa	400	1
*	*Atriplex prostrata*	10	1

Note: * depicts an introduced species

Site: 3	**Location:** -31.967960 115.880260	**Date:** 5-11-2020
Type: Quadrat	**Size:** 10X10	**Community:** CoSq
Topography: Flat	**Soils:** Sand	**Colour:** Brown
Bare ground: None	**Fire:** 10+ years	
Vegetation significance: Subtropical and Temperate Coastal Saltmarsh TEC (EPBC Act-listed Vulnerable)		
Condition: Good		

*	Taxon	Height cm	Foliage %
	Salicornia quinqueflora/S. blackiana	30	40
	Suaeda australis	30	0.5
	Juncus kraussii subsp. australiensis	80	40
	Tecticornia indica subsp. bidens	100	3
	Casuarina obesa	500	1.5
*	*Atriplex prostrata*	10	2
*	*Cotula turbinata*	5	0.5

Note: * depicts an introduced species

Site: 4	**Location:** -31.968002 115.878844	**Date:** 5-11-2020
Type: Quadrat	**Size:** 10X10	**Community:** CoSq
Topography: Low flat	**Soils:** Sand	**Colour:** Brown
Bare Ground: none	**Fire:** 10+ years	
Vegetation significance: Subtropical and Temperate Coastal Saltmarsh TEC (EPBC Act-listed Vulnerable)		
Condition: Good		

*	Taxon	Height cm	Foliage %
	Salicornia quinqueflora/S. blackiana	*30*	*98*
	Suaeda australis	*40*	*1*

Note: * depicts an introduced species

Site: 5	**Location:** -31.964052 115.885608	**Date:** 5-11-2020
Type: Quadrat	**Size:** 10X10	**Community:** PLJk
Topography: Flat lake edge	**Soils:** Sand	**Colour:** Brown
Bare Ground: 20%	**Fire:** 10+ years	
Vegetation significance: NA		
Condition: Degraded		

*	Taxon	Height cm	Foliage %
	Eucalyptus ?sargentii	*1200*	*25*
	Juncus kraussii subsp. australiensis	*50*	*20*
	Suaeda australis	*30*	*10*

*	Taxon	Height cm	Foliage %
	Salicornia quinqueflora/S. blackiana	*10*	*1*
	Casuarina obesa	*250*	*2*

Site: 6	**Location:** -31.968317 115.877831	**Date:** 5-11-2020
Type: Quadrat	**Size:** 10X10	**Community:** PLJk
Topography: Flat lake edge	**Soils:** Sand	**Colour:** Brown
Bare Ground: 5%	**Fire:** 10+ years	
Vegetation significance: NA		
Condition: Degraded		

*	Taxon	Height cm	Foliage %
	Eucalyptus suggrandis subsp. suggrandis	300	5
	Suaeda australis	40	10
	Salicornia quinqueflora/S. blackiana	30	1

*	Taxon	Height cm	Foliage %
	Juncus kraussii subsp. australiensis	100	70
	Casuarina obesa	50	0.1
*	*Hordeum leporinum*	15	1
*	*Atriplex prostrata*	20	0.5

Note: * depicts an introduced species

Appendix D

Black Cockatoo Breeding Habitat Trees

Unique ID	Species	Coordinates		Tree Height (m)	DBH (cm)	DBH comments	No. of Potentially Suitable Hollows	Hollow Comments
1	Tuart	115.87625	-31.9647	12	51		0	
2	Tuart	115.87634	-31.96469	12	55		0	
3	Flooded Gum	115.88006	-31.96578	15	52		0	
4	Stag	115.87999	-31.9659	10	51		0	
5	Sugar gum	115.88292	-31.96689	15	72		0	
6	Sugar gum	115.88296	-31.96693	12	56		0	
7	Sugar gum	115.88292	-31.96694	12	56		0	
8	Introduced	115.8784	-31.9668	5	51		0	
9	Moort	115.87841	-31.9668	12	55		0	
10	Introduced	115.8784	-31.9668	8	60	DBH taken above fork	0	
11	Sugar gum	115.87851	-31.96687	12	55		0	
12	Sugar gum	115.87854	-31.96686	15	65		0	
13	River Red Gum	115.8766	-31.9684	15	60		0	
14	River Red Gum	115.87657	-31.96837	15	60		0	
15	Swamp Mallet	115.87746	-31.96847	15	52		0	
16	Swamp Mallet	115.87742	-31.96844	10	80		0	
17	Sugar gum	115.87844	-31.96753	12	60		0	
18	River Red Gum	115.8864	-31.96444	15	60		0	
19	Flooded Gum	115.88678	-31.96418	14	70		0	
20	Flooded Gum	115.88676	-31.96413	15	80		0	
21	Flooded Gum	115.88676	-31.96409	12	100		0	
22	River Red Gum	115.88696	-31.9639	15	60		0	
23	River Red Gum	115.887	-31.9639	12	55		0	
24	Flooded Gum	115.88459	-31.96514	10	52		0	
25	River Red Gum	115.88702	-31.96382	12	90		0	
26	Flooded Gum	115.88697	-31.96362	14	100		0	
27	Flooded Gum	115.88693	-31.96362	12	60		0	
28	River Red Gum	115.88469	-31.96528	12	90		0	
29	Flooded Gum	115.88455	-31.96543	14	54		0	
30	Flat Topped Yate	115.88677	-31.96357	15	90		0	
31	River Red Gum	115.88485	-31.96527	12	60		0	
32	River Red Gum	115.88485	-31.96517	12	60		0	
33	River Red Gum	115.88738	-31.96348	14	51		0	
34	River Red Gum	115.88493	-31.96555	14	65		0	
35	River Red Gum	115.88496	-31.96564	12	90		0	
36	Swamp Mahogany	115.88506	-31.96573	10	50		0	
37	River Red Gum	115.88734	-31.96334	14	54		0	
38	River Red Gum	115.88736	-31.9633	12	50		0	
39	River Red Gum	115.88513	-31.96559	12	80		0	
40	River Red Gum	115.88735	-31.96328	10	60		0	
41	Flooded Gum	115.88502	-31.96549	12	55		0	
42	Sugar gum	115.8876	-31.96265	16	50		0	
43	Sugar gum	115.88761	-31.96264	15	56		0	
44	River Red Gum	115.8849	-31.96486	12	80		0	
45	Sugar gum	115.88763	-31.96265	16	50		0	
46	River Red Gum	115.88493	-31.96473	10	55		0	
47	Flooded Gum	115.88526	-31.96473	12	80		0	
48	Flooded Gum	115.88505	-31.96461	12	60		0	
49	River Red Gum	115.88508	-31.96477	12	85		0	
50	River Red Gum	115.88509	-31.96474	14	110		0	
51	River Red Gum	115.88519	-31.96486	12	67		0	
52	Flooded Gum	115.88537	-31.96492	14	60		0	
53	Flooded Gum	115.88525	-31.96485	12	62		0	
54	River Red Gum	115.88609	-31.96253	10	60		0	
55	River Red Gum	115.88503	-31.96451	10	66		0	
56	River Red Gum	115.88511	-31.96443	12	82		0	
57	River Red Gum	115.88584	-31.96329	10	53		0	
58	River Red Gum	115.88516	-31.96434	12	60		0	
59	River Red Gum	115.88524	-31.96435	12	65		0	
60	River Red Gum	115.88531	-31.96443	10	54		0	
61	River Red Gum	115.88576	-31.96463	12	61		0	
62	River Red Gum	115.88587	-31.96478	10	55		0	
63	River Red Gum	115.88579	-31.96484	12	54		0	
64	River Red Gum	115.88574	-31.96502	14	68		0	
65	River Red Gum	115.88563	-31.96503	12	57		0	
66	River Red Gum	115.88559	-31.96509	12	68		0	
67	River Red Gum	115.88572	-31.97033	20	120		1	South facing hollow, vertical, 10x10 cm hollow entrance, 6 m above ground, trunk hollow. Difficult to assess from ground. Observed galahs and chewing around hollow entrance.

Unique ID	Species	Coordinates		Tree Height (m)	DBH (cm)	DBH comments	No. of Potentially Suitable Hollows	Hollow Comments
68	Flooded Gum	115.88552	-31.97022	15	87		0	
69	Flooded Gum	115.88397	-31.97153	12	180	DBH taken below fork	0	
70	Flooded Gum	115.88085	-31.97298	10	58		0	
71	Flooded Gum	115.88054	-31.97302	20	110		0	
72	Flooded Gum	115.88042	-31.97297	20	100	Three forks	0	
73	Flooded Gum	115.88023	-31.97303	20	100		0	
74	Flooded Gum	115.88016	-31.97291	14	90		0	
75	Marri	115.88023	-31.97278	9	53		0	
76	Marri	115.88044	-31.97278	9	53		0	
77	Flooded Gum	115.87881	-31.97317	7	55		0	
78	Flooded Gum	115.87892	-31.97315	6	50		0	
79	Wandoo	115.87735	-31.97319	20	150		0	
80	Introduced	115.87721	-31.97312	8	65		0	
81	Flooded Gum	115.876	-31.97298	14	140		0	
82	Flooded Gum	115.8776	-31.97126	8	65	DBH taken above fork	0	
83	Flooded Gum	115.87856	-31.97118	8	60		0	
84	Flooded Gum	115.87924	-31.97126	16	60		0	
85	Flooded Gum	115.87928	-31.97129	16	120	DBH estimated, as in fenced compound.	0	
86	Flooded Gum	115.87938	-31.9713	18	80	DBH estimated, as in fenced compound.	0	
87	Flooded Gum	115.87948	-31.97129	18	60	DBH estimated, as in fenced compound.	0	
88	Flooded Gum	115.87954	-31.9713	18	80	DBH estimated, as in fenced compound.	0	
89	Flooded Gum	115.87919	-31.97142	16	90		0	
90	River Red Gum	115.88033	-31.97138	22	180		0	
91	River Red Gum	115.88046	-31.97133	20	70		0	
92	River Red Gum	115.8802	-31.97131	10	55		0	
93	Wandoo	115.88059	-31.97102	20	80		0	
94	River Red Gum	115.88127	-31.97063	11	68		0	
95	Tuart	115.88794	-31.96837	20	80	DBH taken above fork.	0	
96	Tuart	115.88797	-31.96845	17	55		0	
97	Tuart	115.88778	-31.96853	8	50		0	
98	Tuart	115.88789	-31.96836	13	60		0	
99	Introduced	115.88721	-31.96695	22	110		0	
100	Introduced	115.88705	-31.96699	20	90		0	
101	Introduced	115.88815	-31.96647	16	70		0	
102	Introduced	115.88808	-31.96644	10	60		0	
103	Introduced	115.89055	-31.96555	20	100		0	
104	Introduced	115.89052	-31.96549	16	57		0	
105	Introduced	115.89047	-31.96561	15	60		0	
106	Introduced	115.89016	-31.96573	16	65		0	
107	Introduced	115.88987	-31.96589	12	60		0	
108	Introduced	115.88964	-31.966	15	82		0	
109	Introduced	115.88998	-31.96582	10	54		0	
110	Tuart	115.88985	-31.96626	20	150		0	
111	Introduced	115.8894	-31.96616	15	67		0	
112	Introduced	115.88936	-31.96619	15	120	DBH taken below fork	0	
113	Introduced	115.88956	-31.96647	18	55		0	
114	Introduced	115.88949	-31.96642	20	150		0	
115	Introduced	115.88918	-31.96671	22	70		0	
116	Introduced	115.8892	-31.96676	22	70		0	
117	Introduced	115.88916	-31.96634	10	80	DBH taken below fork	0	
118	Introduced	115.8891	-31.96638	15	95		0	
119	York Gum	115.88913	-31.96647	15	61		0	
120	Introduced	115.88923	-31.96687	20	110		0	
121	Introduced	115.88899	-31.96647	15	68		0	
122	Introduced	115.88915	-31.96699	18	160		0	
123	Introduced	115.88891	-31.96708	18	110		0	
124	Introduced	115.88892	-31.96689	15	90		0	
125	Introduced	115.88894	-31.96656	12	82		0	
126	Introduced	115.88864	-31.96673	22	140		0	
127	Introduced	115.88732	-31.96711	12	62		0	
128	Introduced	115.88742	-31.96716	12	51		0	
129	Introduced	115.88751	-31.96723	14	52		0	
130	Introduced	115.88782	-31.96733	20	130		0	

Unique ID	Species	Coordinates		Tree Height (m)	DBH (cm)	DBH comments	No. of Potentially Suitable Hollows	Hollow Comments
131	Introduced	115.88778	-31.96729	16	70		0	
132	Introduced	115.88767	-31.96717	16	100		0	
133	Swamp Mahogany	115.88758	-31.96723	15	62		0	
134	River Red Gum	115.88604	-31.96491	13	60	Contains two potential hollows but neither are sufficiently sized.	0	
135	Red Ironbark	115.88382	-31.96505	20	60		0	
136	Red Ironbark	115.88389	-31.96503	25	90		0	
137	Red Ironbark	115.88392	-31.96502	23	90		0	
138	Red Ironbark	115.88373	-31.96498	15	57		0	
139	River Red Gum	115.88711	-31.96273	22	54		0	
140	River Red Gum	115.88708	-31.96273	18	57		0	
141	River Red Gum	115.88722	-31.96248	13	51		0	
142	River Red Gum	115.88725	-31.96247	18	65		0	
143	River Red Gum	115.88741	-31.96237	20	65		0	
144	Stag	115.88713	-31.96219	16	51		0	
145	River Red Gum	115.88723	-31.96216	18	50		0	
146	River Red Gum	115.88704	-31.96214	25	54		0	
147	Flooded Gum	115.88702	-31.96204	20	59		0	
148	River Red Gum	115.88689	-31.96215	18	56		0	
149	River Red Gum	115.88675	-31.96223	23	80		0	
150	Sugar gum	115.88668	-31.96203	19	60		0	
151	Flooded Gum	115.88607	-31.96217	25	62		0	
152	Red Ironbark	115.88613	-31.96219	25	70		0	
153	River Red Gum	115.88593	-31.9622	18	50		0	
154	Sugar gum	115.88548	-31.96202	20	65		0	
155	River Red Gum	115.88645	-31.96298	15	54		0	
156	Flooded Gum	115.88565	-31.9635	27	65		0	
157	Flooded Gum	115.88561	-31.9635	20	70		0	
158	Flooded Gum	115.88536	-31.96343	25	75		0	
159	Flooded Gum	115.88513	-31.96354	35	100		0	
160	Flooded Gum	115.88494	-31.96361	12	62		0	
161	Flooded Gum	115.88487	-31.9635	16	60		0	
162	Flooded Gum	115.88458	-31.96371	22	90		0	
163	Flooded Gum	115.88439	-31.9639	23	75		0	
164	Flooded Gum	115.88417	-31.96388	21	65		0	
165	Flooded Gum	115.88412	-31.96394	25	100		0	
166	Coastal Moort	115.88418	-31.96369	25	56		0	
167	Flooded Gum	115.88408	-31.96369	22	70		0	
168	Flooded Gum	115.88397	-31.96359	20	70		0	
169	Stag	115.88395	-31.96368	24	53		0	
170	Flooded Gum	115.88389	-31.96376	18	53		0	
171	Flooded Gum	115.88392	-31.96372	20	56		0	
172	Flooded Gum	115.88401	-31.96373	23	51		0	
173	River Red Gum	115.8843	-31.96403	23	90		0	
174	River Red Gum	115.88426	-31.9641	19	95		0	
175	River Red Gum	115.88475	-31.96422	18	65		0	
176	River Red Gum	115.88495	-31.96427	20	62		0	
177	River Red Gum	115.88491	-31.96435	23	53		0	
178	River Red Gum	115.88582	-31.96385	18	70		0	
179	River Red Gum	115.88549	-31.96389	25	100		0	
180	River Red Gum	115.8851	-31.96397	22	90		0	
181	Introduced	115.88509	-31.96385	20	90		0	
182	River Red Gum	115.8844	-31.96435	20	80		0	
183	River Red Gum	115.88427	-31.96433	20	60		0	
184	River Red Gum	115.88363	-31.96471	25	60		0	
185	River Red Gum	115.8837	-31.96478	17	51		0	
186	Flooded Gum	115.88354	-31.96457	20	65		0	
187	Flooded Gum	115.88364	-31.96445	25	55		0	
188	River Red Gum	115.88357	-31.96442	20	51		0	
189	River Red Gum	115.88335	-31.9645	25	60		0	
190	River Red Gum	115.88319	-31.96446	20	55		0	
191	River Red Gum	115.88315	-31.9644	22	65		0	
192	River Red Gum	115.88304	-31.96428	25	60		0	
193	River Red Gum	115.88302	-31.96428	25	55		0	
194	River Red Gum	115.88304	-31.96429	22	70		0	
195	Yate	115.88288	-31.96447	15	63		0	
196	River Red Gum	115.88309	-31.9643	18	70		0	
197	River Red Gum	115.88309	-31.96422	22	75		0	
198	Flooded Gum	115.88359	-31.96414	22	100		0	
199	Flooded Gum	115.88379	-31.96398	20	53		0	
200	River Red Gum	115.8839	-31.96385	22	65		0	
201	River Red Gum	115.88484	-31.96366	25	57		0	
202	River Red Gum	115.88358	-31.9637	30	80		0	
203	River Red Gum	115.88201	-31.96481	25	58		0	
204	River Red Gum	115.88218	-31.9647	20	53		0	

Unique ID	Species	Coordinates		Tree Height (m)	DBH (cm)	DBH comments	No. of Potentially Suitable Hollows	Hollow Comments
205	River Red Gum	115.88224	-31.96478	20	56		0	
206	River Red Gum	115.88232	-31.96471	25	54		0	
207	River Red Gum	115.88242	-31.96493	22	60		0	
208	Flooded Gum	115.88252	-31.96491	25	63		0	
209	River Red Gum	115.88258	-31.96493	15	57		0	
210	River Red Gum	115.8826	-31.96495	25	65		0	
211	River Red Gum	115.88272	-31.96498	25	61		0	
212	River Red Gum	115.8827	-31.96517	23	58		0	
213	River Red Gum	115.88263	-31.96502	22	54		0	
214	River Red Gum	115.88286	-31.96515	30	65		0	
215	River Red Gum	115.88317	-31.96525	50	200		0	
216	River Red Gum	115.88314	-31.96514	12	70		0	
217	Introduced	115.88313	-31.96522	20	65		0	
218	River Red Gum	115.8831	-31.96528	35	60		0	
219	River Red Gum	115.8837	-31.96581	25	65	Bat box in tree	0	
220	River Red Gum	115.88365	-31.96578	20	57	Possum box	0	
221	River Red Gum	115.88358	-31.96577	22	60		0	
222	River Red Gum	115.88357	-31.96573	25	80		0	
223	River Red Gum	115.8835	-31.96574	23	57	Possum box	0	
224	River Red Gum	115.88326	-31.96579	22	60		0	
225	River Red Gum	115.88333	-31.9658	20	54		0	
226	Introduced	115.88341	-31.96581	25	65		0	
227	River Red Gum	115.88345	-31.96584	27	65		0	
228	Port Lincoln Gum	115.88295	-31.96569	27	55		0	
229	Port Lincoln Gum	115.88283	-31.96571	21	58		0	
230	Port Lincoln Gum	115.88279	-31.96572	24	60		0	
231	Coral Gum	115.8839	-31.96587	11	54		0	
232	Coral Gum	115.88396	-31.96588	15	57		0	
233	River Red Gum	115.88411	-31.966	22	62		0	
234	River Red Gum	115.8842	-31.96607	26	51		0	
235	River Red Gum	115.88412	-31.96608	26	54		0	
236	River Red Gum	115.88391	-31.96616	27	65		0	
237	River Red Gum	115.88393	-31.9661	26	60		0	
238	River Red Gum	115.88394	-31.96626	22	51		0	
239	River Red Gum	115.88389	-31.96632	23	52		0	
240	River Red Gum	115.88394	-31.96636	23	75		0	
241	River Red Gum	115.88385	-31.96645	19	51		0	
242	River Red Gum	115.8834	-31.96655	28	70		0	
243	River Red Gum	115.8834	-31.96645	25	65		0	
244	River Red Gum	115.88238	-31.96572	20	75		0	
245	River Red Gum	115.88249	-31.96571	26	57		0	
246	River Red Gum	115.88244	-31.96578	28	55		0	
247	River Red Gum	115.88238	-31.96578	30	62		0	
248	River Red Gum	115.88235	-31.96564	23	65		0	
249	River Red Gum	115.88224	-31.96567	24	54		0	
250	River Red Gum	115.88216	-31.96564	26	60		0	
251	River Red Gum	115.88213	-31.96561	23	65		0	
252	River Red Gum	115.88211	-31.9656	22	75		0	
253	River Red Gum	115.88206	-31.96565	21	80		0	
254	River Red Gum	115.8819	-31.96533	27	75		0	
255	River Red Gum	115.88203	-31.96528	27	60		0	
256	River Red Gum	115.882	-31.96524	26	70		0	
257	River Red Gum	115.88105	-31.96589	18	70		0	
258	River Red Gum	115.88133	-31.96597	19	52		0	
259	Sugar gum	115.88262	-31.96615	23	65		0	
260	Sugar gum	115.88273	-31.96617	24	58		0	
261	Flat Topped Yate	115.88273	-31.96629	16	58		0	
262	Flat Topped Yate	115.88304	-31.96653	17	120	Termite activity	0	
263	Flat Topped Yate	115.88313	-31.96659	20	70		0	
264	River Red Gum	115.87754	-31.96735	24	80		0	
265	River Red Gum	115.87753	-31.96727	25	70		0	
266	Flooded Gum	115.87751	-31.96737	22	53		0	
267	Stag	115.87747	-31.96721	28	75	Recently dead	0	
268	Stag	115.87742	-31.96726	18	50		0	
269	Flooded Gum	115.87728	-31.96728	20	51		0	
270	Flooded Gum	115.8773	-31.96731	23	61		0	
271	Flooded Gum	115.87716	-31.96752	26	53		0	
272	River Red Gum	115.87704	-31.96744	24	75		0	
273	River Red Gum	115.87696	-31.96748	23	80		0	
274	River Red Gum	115.87709	-31.9676	21	55		0	
275	Flooded Gum	115.87704	-31.96774	18	70		0	
276	Flooded Gum	115.87731	-31.96798	22	70		0	
277	Flooded Gum	115.87728	-31.96811	23	75		0	
278	Flooded Gum	115.87718	-31.96806	22	80		0	

Unique ID	Species	Coordinates		Tree Height (m)	DBH (cm)	DBH comments	No. of Potentially Suitable Hollows	Hollow Comments
279	Flooded Gum	115.87709	-31.96805	24	55		0	
280	Flooded Gum	115.87698	-31.96807	20	59		0	
281	Flooded Gum	115.87686	-31.96799	25	85		0	
282	Flooded Gum	115.87682	-31.9679	19	51		0	
283	Flooded Gum	115.87681	-31.96775	20	51		0	
284	Flooded Gum	115.87718	-31.96787	23	90		0	
285	River Red Gum	115.88127	-31.96521	22	80		0	
286	River Red Gum	115.88133	-31.96528	19	61		0	
287	River Red Gum	115.88133	-31.9652	23	64		0	
288	Introduced	115.88138	-31.96517	20	55		0	
289	River Red Gum	115.88142	-31.96523	24	58		0	
290	River Red Gum	115.88144	-31.96524	21	52		0	
291	River Red Gum	115.88146	-31.96522	20	54		0	
292	River Red Gum	115.88165	-31.96518	19	59		0	
293	Introduced	115.88146	-31.96508	21	62		0	
294	River Red Gum	115.88177	-31.96506	18	75		0	
295	River Red Gum	115.88173	-31.96499	17	52		0	
296	River Red Gum	115.88173	-31.96488	18	54		0	
297	River Red Gum	115.88185	-31.96502	20	59		0	
298	River Red Gum	115.88182	-31.96489	19	65		0	
299	River Red Gum	115.88185	-31.96488	20	60		0	
300	River Red Gum	115.88192	-31.96484	20	58		0	
301	River Red Gum	115.88189	-31.965	18	66		0	
302	River Red Gum	115.882	-31.96492	17	70		0	
303	River Red Gum	115.88201	-31.9649	16	51		0	
304	River Red Gum	115.88214	-31.96489	18	65		0	
305	River Red Gum	115.88221	-31.96497	19	61		0	
306	Introduced	115.88235	-31.96509	18	51		0	
307	River Red Gum	115.88252	-31.96518	24	62		0	
308	River Red Gum	115.88246	-31.96533	27	54		0	
309	River Red Gum	115.88252	-31.96529	26	60		0	
310	River Red Gum	115.88263	-31.96527	27	60		0	
311	River Red Gum	115.88264	-31.96529	25	51		0	
312	River Red Gum	115.88269	-31.96524	28	70		0	
313	Flooded Gum	115.88156	-31.97326	17	50		0	
314	Flooded Gum	115.8816	-31.97321	18	67		0	
315	Flooded Gum	115.88165	-31.97288	12	57		0	
316	Flooded Gum	115.88197	-31.9728	18	95		0	
317	Flooded Gum	115.88197	-31.97275	17	57		0	
318	Flooded Gum	115.882	-31.97274	14	50		0	
319	Flooded Gum	115.88192	-31.97273	17	57		0	
320	Flooded Gum	115.88175	-31.97266	18	80		0	
321	Flooded Gum	115.88179	-31.97269	22	75		0	
322	Flooded Gum	115.88183	-31.97263	16	53		0	
323	Flooded Gum	115.88185	-31.9726	20	75		0	
324	Flooded Gum	115.88191	-31.97255	22	66		0	
325	Flooded Gum	115.88193	-31.97251	25	110		0	
326	Flooded Gum	115.88212	-31.97273	18	58		0	
327	Flooded Gum	115.88216	-31.97271	27	100		0	
328	Flooded Gum	115.88218	-31.97269	20	63		0	
329	Flooded Gum	115.88209	-31.97265	25	69		0	
330	River Red Gum	115.88196	-31.97242	27	65		0	
331	Flooded Gum	115.88195	-31.97203	20	70		0	
332	Flooded Gum	115.88195	-31.97225	19	120		0	
333	Flooded Gum	115.88197	-31.97233	24	130		0	
334	Flooded Gum	115.88205	-31.9724	23	75		0	
335	Flooded Gum	115.88211	-31.97242	22	80		0	
336	Flooded Gum	115.88218	-31.9724	26	85		0	
337	Flooded Gum	115.88223	-31.97216	35	250		0	
338	Flooded Gum	115.88237	-31.97224	25	100		0	
339	River Red Gum	115.88218	-31.97253	18	60		0	
340	Introduced	115.88224	-31.97256	18	60		0	
341	Flooded Gum	115.88222	-31.97249	27	90		0	
342	Flooded Gum	115.8822	-31.97246	26	80		0	
343	Flooded Gum	115.88224	-31.97246	25	62		0	
344	Flooded Gum	115.88249	-31.9724	20	65		0	
345	Flooded Gum	115.88253	-31.97238	24	80		0	
346	Flooded Gum	115.88249	-31.97233	27	120		0	
347	Flooded Gum	115.88256	-31.97244	28	200		0	
348	Flooded Gum	115.8825	-31.97264	27	110		0	
349	River Red Gum	115.8826	-31.97266	17	62		0	
350	Introduced	115.88265	-31.97271	17	80		0	
351	Flooded Gum	115.88276	-31.97254	15	100		0	
352	Flooded Gum	115.88281	-31.97233	18	120		0	
353	Flooded Gum	115.88282	-31.9728	15	55		0	
354	Flooded Gum	115.88287	-31.97285	18	80		0	
355	Flooded Gum	115.88301	-31.97276	12	68		0	
356	Sugar gum	115.88295	-31.97273	12	58		0	
357	Sugar gum	115.88287	-31.97263	11	62		0	
358	Flooded Gum	115.88295	-31.97257	12	70		0	

Unique ID	Species	Coordinates		Tree Height (m)	DBH (cm)	DBH comments	No. of Potentially Suitable Hollows	Hollow Comments
359	Flooded Gum	115.88302	-31.97255	18	70		0	
360	Flooded Gum	115.88317	-31.97254	20	90		0	
361	Flooded Gum	115.88321	-31.97244	22	100		0	
362	Flooded Gum	115.88321	-31.97233	25	150		0	
363	Flooded Gum	115.88332	-31.9722	8	62		0	
364	Flooded Gum	115.88336	-31.97223	19	70		0	
365	Flooded Gum	115.8834	-31.97222	23	85		0	
366	Flooded Gum	115.88356	-31.97209	24	80		0	
367	Flooded Gum	115.88358	-31.97198	15	67		0	
368	Flooded Gum	115.88342	-31.97198	18	65		0	
369	Flooded Gum	115.88344	-31.97195	19	90		0	
370	Flooded Gum	115.88345	-31.97193	14	80		0	
371	River Red Gum	115.88052	-31.97141	20	65		0	
372	Flooded Gum	115.88074	-31.9717	26	180		0	
373	Flooded Gum	115.8813	-31.97197	25	80		0	
374	Flooded Gum	115.88138	-31.97211	24	60		0	
375	Flooded Gum	115.8815	-31.97203	22	85		0	
376	Flooded Gum	115.88153	-31.97201	25	100		0	
377	Flooded Gum	115.88154	-31.97203	20	65		0	
378	Flooded Gum	115.88165	-31.9723	18	100		0	
379	Red Ironbark	115.88147	-31.97245	17	57		0	
380	Red Ironbark	115.88147	-31.97251	18	61		0	
381	Swamp Mahogany	115.88153	-31.97301	16	59		0	
382	River Red Gum	115.87831	-31.96296	23	60		0	
383	River Red Gum	115.87836	-31.96295	24	75		0	
384	Rose Gum	115.87868	-31.96318	26	65		0	
385	Spotted Gum	115.87901	-31.96319	20	55		0	
386	Rose Gum	115.8791	-31.96326	21	54		0	
387	Introduced	115.87887	-31.96246	18	70		0	
388	Bangalay	115.87908	-31.96246	22	95		0	
389	Spotted Gum	115.87915	-31.96237	25	55		0	
390	Spotted Gum	115.87899	-31.96275	21	70		0	
391	Tuart	115.87888	-31.9635	18	60		0	
392	Flooded Gum	115.87896	-31.96357	16	59		0	
393	Tuart	115.87903	-31.96351	20	62		0	
394	Flooded Gum	115.87987	-31.96356	20	60		0	
395	Flooded Gum	115.88027	-31.9639	17	65		0	
396	Tuart	115.88088	-31.96383	20	55		0	
397	Tuart	115.87884	-31.96401	18	70		0	
398	Flooded Gum	115.87808	-31.96405	19	55		0	
399	Flooded Gum	115.87796	-31.96411	18	55		0	
400	Flooded Gum	115.87788	-31.96412	19	60		0	
401	Flooded Gum	115.87784	-31.96416	17	60		0	
402	Flooded Gum	115.878	-31.96424	16	52		0	
403	Flooded Gum	115.87813	-31.96438	17	65		0	
404	Flooded Gum	115.87814	-31.96458	20	140		0	
405	Flooded Gum	115.87802	-31.96441	21	56		0	
406	Flooded Gum	115.87791	-31.96457	19	60		0	
407	Flooded Gum	115.8779	-31.9647	16	53		0	
408	Flooded Gum	115.87796	-31.96386	15	50		0	
409	Flooded Gum	115.87768	-31.96394	18	51		0	
410	Flooded Gum	115.87757	-31.96399	17	53		0	
411	Tuart	115.87754	-31.96419	23	70		0	
412	Flooded Gum	115.87764	-31.96428	20	52		0	
413	Flooded Gum	115.87745	-31.96441	17	50		0	
414	Flooded Gum	115.87744	-31.96488	20	85		0	
415	Flooded Gum	115.8778	-31.96462	16	60		0	
416	Flooded Gum	115.87738	-31.9641	15	52		0	

Appendix E

BCE Black Cockatoo Foraging Habitat Scoring System

Appendix E Bamford Consulting Ecologists (BCE) Black Cockatoo Scoring System

Introduction

Application of the Offset Assessment Guide (offsets guide) developed by the federal environment department for assessing Black-Cockatoo foraging habitat requires the calculation of a score out of 10. The following system has been developed by Bamford Consulting Ecologists (BCE) with assistance from Quessentia Consulting to provide an objective scoring system that is practical and can be used by trained field zoologists with experience in the environments frequented by the species.

The foraging value score provides a numerical value that reflects the significance of vegetation as foraging habitat for Black-Cockatoos, and this numerical value is designed to provide the information needed by the Federal Department of Agriculture, Water and the Environment (DAWE) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed above. These three components are drawn from the DAWE offsets guide but the scoring approach was developed by BCE and includes a fourth (moderation) component.

Note that the scoring system can only be applied within the range of the species or at least where the species could reasonably be expected to occur based upon existing information.

Calculating the total score (out of 10) requires the following steps:

a. Site condition. Determining a score out of six for the vegetation composition, condition and structure; plus

b. Site context. Determining a score out of three for the context of the site; plus

c. Species stocking rate. Determining a score out of one for species density.

d. Determining the total score out of 10, which may require moderation for context and species density with respect to the site condition (vegetation) score. Moderation also includes consideration of pine plantations as a special case for foraging value.

The BCE scoring system places the greatest weight on site condition (scale of 0 to 6) because this has the highest influence on the foraging values of a site, which in turn is the fundamental driver in meeting ecological requirements for continued survival.

Site context has a lower weight (scale of 0 to 3) in recognition of the mobility of the species, which means they can access good foraging habitat even in fragmented landscapes, but allowing for recognition of the extent of available habitat in a region and context in relation to activity (such as breeding and roosting). The application of scoring site context is further discussed below.

Species stocking rate is given a low weight (0 to 1) as it is a means only of recognising that a species may or may not be abundant at a site, but that abundance is dependent upon site condition and context and is thus not an independent variable. The abundance of a species is also sensitive to sampling effort, and to seasonal and annual variation, and is therefore an unreliable indicator of actual importance of a site to a species.

Calculation of scores and the moderation process are described in detail below.

1.1 Site Condition

Table 1 Site Condition: Vegetation Composition, Condition and Structure Scoring

Site Score	Description of Vegetation Values		
	Carnaby's Black Cockatoo	**Baudin's Black Cockatoo**	**Forest Red-tailed Black Cockatoo**
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples: • Water bodies (e.g. salt lakes, dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits) or with vegetation of no food value, such as some suburban landscapes. • Mown grass	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits).	No foraging value. No eucalypts or other potential sources of food. Examples: • Water bodies (e.g. dams, rivers); • Bare ground; • Developed sites devoid of vegetation (e.g. infrastructure, roads, gravel pits)
1	Negligible to low foraging value. Examples: • Scattered specimens of known food plants but projected foliage cover of these is < 2%. This could include urban areas with scattered foraging trees; • Paddocks that are lightly vegetated with melons or other known food-source weeds (e.g. Erodium spp.) that represent a short-term and/or seasonal food source; • Blue Gum plantations (foraging by Carnaby's Black-Cockatoos has been reported but appears to be unusual).	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. This could include urban areas with scattered foraging trees.	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these < 1%. Could include urban areas with scattered foraging trees.
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have <10% projected foliage cover; • Woodland with tree banksias 2-5% projected foliage cover; • Open eucalypt woodland/mallee of small- • fruited species;	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri and Jarrah) 1-5% projected foliage cover; • Urban areas with scattered foraging trees.	Low foraging value. Examples: • Woodland with scattered specimens of known food plants (e.g. Marri, Jarrah or Sheoak) 1-5% projected foliage cover; • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *E. erythrocorys*.

Site Score	Description of Vegetation Values		
	Carnaby's Black Cockatoo	**Baudin's Black Cockatoo**	**Forest Red-tailed Black Cockatoo**
	• Paddocks that are densely vegetated with melons or other known food-source weeds (e.g. Erodium spp.) that represent a short-term and/or seasonal food source.		
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, have 10-20% projected foliage cover; • Woodland with tree banksias 5-20% projected foliage cover; • Eucalypt Woodland/Mallee of small-fruited species; • Eucalypt Woodland with Marri < 10% projected foliage cover	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri) 5-20% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).	Low to Moderate foraging value. Examples: • Eucalypt Woodland with known food plants (especially Marri and Jarrah) 5-20% projected foliage cover; • Parkland-cleared Eucalypt Woodland/Forest with known food plants 10-40% projected foliage cover (poor long-term viability without management); • Younger areas of (managed) revegetation with known food plants 10-40% projected foliage cover (establishing food sources with good long-term viability).
4	Moderate foraging value. Examples: • Woodland/low forest with tree banksias (of key species B. attenuata and B. menziesii) 20-40% projected foliage cover; • Kwongan/ Shrubland in which species of foraging value, such as shrubby banksias, have 20-40% projected foliage cover; • Eucalypt Woodland/Forest with Marri 20-40% projected foliage cover.	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths. • Eucalypt Woodland/Forest with diverse, healthy understorey and known food trees (especially Marri) 10-20% projected foliage cover. • Orchards with highly desirable food sources (e.g. apples, pears, some stone fruits).	Moderate foraging value. Examples: • Marri-Jarrah Woodland/Forest with 20-40% projected foliage cover; • Marri-Jarrah Forest with 40-60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Sheoak Forest with 40-60% projected foliage cover.
5	Moderate to High foraging value. Examples:	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover;	Moderate to High foraging value. Examples: • Marri-Jarrah Forest with 40-60% projected foliage cover;

Site Score	Description of Vegetation Values		
	Carnaby's Black Cockatoo	**Baudin's Black Cockatoo**	**Forest Red-tailed Black Cockatoo**
	• Banksia Low Forest (of key species B. attenuata and B. menziesii) with 40-60% projected foliage cover; • Banksia Low Forest (of key species B. attenuata and B. menziesii) with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths; • Pine plantations with trees more than 10 years old (but see pine note below in moderation section).	• Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths.	• Marri-Jarrah Forest with > 60% projected foliage cover but vegetation condition reduced due to weed invasion and/or some tree deaths. • Sheoak Forest with > 60% projected foliage cover.
6	High foraging value. Example: • Banksia Low Forest (of key species B. attenuata and B. menziesii) with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).	High foraging value. Example: • Marri-Jarrah Forest with > 60% projected foliage cover and vegetation condition good with low weed invasion and/or low tree deaths (indicating it is robust and unlikely to decline in the medium term).

Vegetation structural class terminology follows Keighery (1994).

1.2 Site Context

Site Context is a function of site size, availability of nearby habitat and the availability of nearby breeding areas. Site context includes consideration of connectivity, although Black-Cockatoos are very mobile and will fly across paddocks to access foraging sites. Based on BCE observations, Black-Cockatoos are unlikely to regularly go over open ground for a distance of more than a few kilometres and prefer to follow tree-lines.

The maximum score for site context is 3, and because it is effectively a function of presence/absence of nearby breeding and the distribution of foraging habitat across the landscape, the following table, developed by Bamford Consulting in conjunction with DEE, provides a guide to the assignation of site context scores. Note that 'local area' is defined as within a 15 km radius of the centre point of the study site. This is greater than the maximum distance of 12km known to be flown by Carnaby's Black-Cockatoo when feeding chicks in the nest.

Table 2 Site Context Weighting

Site Context Score	Percentage of the existing native vegetation within the 'local' area that the study site represents	
	'Local' breeding known/likely	'Local' breeding unlikely
3	>5%	>10%
2	1-5%	5-10%
1	0.1-1%	1-5%
0	<0.1%	<1%

The table above provides weighting for where nearby breeding is known (or suspected) and for the proportion of foraging habitat within 15km represented by the site being assessed. Some adjustments may be needed based on the judgement of the assessor and in relation to the likely function of the site. For example, a small area of foraging habitat (e.g. 0.5% of such habitat within 15km) could be upgraded to a context of 2 if it formed part of a critical movement corridor. In contrast, the same sized area of habitat, of the same local proportion, could be downgraded if it were so isolated that birds could never access it.

1.3 Species Density (Stocking Rate)

Species stocking rate is described as "the usage and/or density of a species at a particular site" in the offsets guide. The description also implies that a site supports a discrete population, which is unlikely in the case of very mobile black-cockatoos. Assignation of the species density score (0 or 1) is based upon the black-cockatoo species being either abundant or not abundant. A score of 1 is used where the species is seen or reported regularly and/or there is abundant foraging evidence.

Regularly is when the species is seen at intervals of every few days or weeks for at least several months of the year. A score of 0 is used when the species is recorded or reported very infrequently and there is little or no foraging evidence. Where information on actual presence of birds is lacking, a species density score can be assigned by interpreting the landscape and the site context. For example, a site with a moderate condition score that is part of a network of such habitat where a black-cockatoo species is known would get a species density score of 1 even without clear presence data, while a species density score of 0 can be assigned to a site where the level of usage can confidently be predicted to be low.

1.4 Moderation of scores for the calculation of a value out of 10

The calculation out of 10 requires the vegetation characteristics (out of 6) to be combined with the scores given for context and species density. It is considered that the context and density scores are not independent of vegetation characteristics, otherwise habitat of absolutely no value for black-cockatoo foraging (such as concrete or a wetland) could get a foraging score out of 10 as high as 4 if it occurred in an area where the species breed (context score of 3) and are abundant (species density

score of 1). Similarly, vegetation of negligible or low characteristics which could not support black-cockatoos could be assigned a score as high as 6 out of 10. In that case, the score of 6 would be more a reflection of nearby vegetation of high characteristics than of the foraging value of the negligible to low scoring vegetation. The Black-Cockatoos would only be present because of vegetation of high characteristics, so applying the context and species density scores to vegetation of low characteristics would not give a true reflection of their foraging value.

For this reason, the context and species density scores need to be moderated for the vegetation characteristic score to prevent vegetation of little or no foraging value receiving an excessive score out of 10. A simple approach is to assign a context and species density score of zero to sites with a Condition score of low (2), negligible (1) or none (0), on the basis that birds will not use such areas unless they are adjacent to at least low-moderate quality foraging habitat (>3). The approach to calculating a score out of 10 can be summarised as follows:

Table 3 Moderation of scores

Vegetation composition, condition and structure score (out of 6)	Context score	Species density score
3-6 (low/moderate to high value)	Assessed as per Section 1.2 above	Assessed as per Section 1.3 above
0-2 (no to low value)	0	0

Note that this moderation approach may require interpretation depending on the context. For example, vegetation with a condition score of 2 could be given a context score of 1 under special circumstances. Such as when very close to a major breeding area or if strategically located along a movement corridor.

Appendix F

Black Cockatoo Foraging Habitat Assessment

Confirmed white-tailed roosts within 12km (Birdlife 2020)
Breeding confirmed within 12km of surve area (GoWA, 2018)
Foraging evidence not found in survey area

	Carnaby's Black Cockatoo				Forest Red-tailed Black Cockatoo				
Habitat	**Site Condition**	**Site Context**	**Species Density**	**Final Score**	**Site Condition**	**Site Context**	**Species Density**	**Final Score**	**General Comments**
Hardstand	0	0	0	**0**	0	0	0	**0**	No foraging species present. Bare ground.
Parkland and Maintained Gardens with foraging species	1	0	0	**1**	2	0	0	**2**	Parkland and maintained gardens on the SCP with occasional foraging plant recorded. No foraging evidence or direct sightings recorded.
Parkland and Maintained Gardens with no foraging species	0	0	0	**0**	0	0	0	**0**	Parkland and maintained gardens on the SCP wih no foraging species present. No foraging evidence or direct sightings recorded.
Small stands of mixed trees - generally with low foraging quality	1	0	0	**1**	1	0	0	**1**	Small stands of trees including introduced and native eucalypts that include some, generally low foraging species. Foraging evidence or direct sightings not recorded.
Small stands of mixed trees with foraging species	1	0	0	**1**	2	0	0	**2**	Small stands of introduced and native eucalypts on the SCP. Foraging evidence or direct sightings not recorded.
Small stands of mixed trees with no foraging species	0	0	0	**0**	0	0	0	**0**	Small stands of mixed trees on the SCP with no foraging species present. Foraging evidence or direct sightings not recorded.
Wetland/Water	0	0	0	**0**	0	0	0	**0**	Water body that provides no foraging value.
Riparian vegetation with no foraging	0	0	0	**0**	0	0	0	**0**	Habitat contains no foraging species.
Small areas of riparian vegetation with occasional foraging species	1	0	0	**1**	2	0	0	**2**	Riparian vegetation on the SCP containing occassional foraging species. No foraging evidence or direct sightings recorded.