4. Inland Waters

The EPA defines inland waters as "the occurrence, distribution, connectivity, movement, and quantity (hydrological regimes) of inland water including its chemical, physical, biological and aesthetic characteristics (quality)".

The EPA's objective for Inland Waters is "to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected" (EPA 2018b).

This chapter provides information relating to inland waters within the ERB and identifies associated potential constraints to the MEL project.

4.1 Relevant guidance

The following policies and guidance are relevant to the Inland Waters factor:

- Environmental Factor Guideline: Inland Waters (EPA 2018b)
- A guide to managing and restoring wetlands in Western Australia (DEC 2012d)
- Wetlands Conservation Policy for Western Australia (Government of Australia 1997)
- Environmental Water Provisions Policy for Western Australia (Water and Rivers Commission 2000)

4.2 Information sources

4.2.1 Databases searches

The following dataset and database searches were undertaken to support this analysis:

- Landgate: Geomorphic wetlands of the Swan Coastal Plain
- DWER Perth groundwater atlas
- 100 year ARI floodplain development control area

4.2.2 Reports provided by the PTA or publicly available

Numerous reports containing information relevant to Inland Waters and the MEL project have been prepared in association with projects located partially within, or near to, the ERB and have been reviewed to inform this analysis (Table 4-1).

Table 4-1: Key reports reviewed relevant to inland waters

Title	Author	Year	Summary of scope
Morley to Ellenbrook Route protection study MEL Option 2 Environment and Heritage Assessment	Jacobs	2018	Identification of environmental constraints associated with the preliminary alignment.
Report METRONET water considerations	Department of Water and Environmental Regulation and the Water Corporation	2017	Summary of water considerations for the METRONET Morley to Ellenbrook line, water availability and design, recommendations for application of water sensitive urban design, consideration of the Gnangara public drinking water source area (PDWSA) and bores and risks of land intensification.
Groundwater level monitoring data October 2017 monitoring round NorthLink Stage 1 Highway Project – southern section	Golder	2017	Groundwater level monitoring
Swan Canning catchment update Nutrient report update 2015	Department of Water and Department of Parks and Wildlife	2015	Overview of Bennett Brook and its catchment, including changes of flow and groundwater levels over time and results of nutrient monitoring.
NorthLink WA Perth – Darwin National Highway Wetland Assessment	Coffey	2015	Assessment of potential impacts to wetlands located within or adjacent to the NorthLink project area including desktop wetland assessment, wetland site investigation including identification of groundwater dependent ecosystems.
Position paper NorthLink WA Hydrogeological PER considerations – construction, dewatering and groundwater abstraction.	MRWA	2015	Hydrogeological assessment to address review comments from OEPA on NorthLink Draft
Public Environmental Review PDNH (Swan Valley Section) (Coffey, 2015) including appendices.	Coffey	2015	Public Environmental Review for NorthLink, including identification of existing environmental values, assessment of potential impacts and identification of management measures.
Due diligence report: Long-stay caravan park, Marshall Road, Whiteman	RPS	2015	Due diligence report of environmental constraints for proposed long-stay caravan park at Marshall Road, Whiteman.
Bennett Brook Catchment – water and sediment quality monitoring and evaluation: Ten-year analysis 2002-2011	South East Regional Centre for Urban Landcare	2013	Summary of findings of ten years of study of the Bennett Brook catchment including water and sediment quality.
Horse Swamp Environmental Management Plan	Cook	2011	A university project report providing a summary of physical, biological and social values of Horse Swamp and management issues.
Local Water Quality Improvement Plan	Government of Western Australia	2011	Identification and summary of nutrient and pollutant pathways through Bennett Brook from their source to the discharge point.

4.2.3 Information coverage

Field surveys and investigations have been undertaken within the ERB in relation to the NorthLink project and a proposed caravan park at Marshall Road, Whiteman. NorthLink coincides with the southern section of the ERB and, given the recent nature of the project, this information is expected to remain valid for identification of key values relating to this portion of the MEL. Numerous other reports have been prepared on environmental values outside of the ERB, in relation to the previously proposed Ellenbrook Bus Rapid Transit route, residential subdivisions east of Lord Street and for general environmental and wetland management planning. These reports provide further contextual information.

It should be noted that while previous reports/surveys have indicated the presence of an environmental value, as a result of the project's implementation, these values may no longer be present. Further verification of presence/absence may be required at a later date.

4.3 Description of relevant environmental values

Desktop and field surveys to date provide background information on the existing surface water and groundwater values both within, and in the vicinity of, the ERB. This information is summarised below.

4.3.1 Surface water

The ERB is located almost entirely within the boundaries of the Bennett Brook catchment. As of 2014, just over half of the catchment was covered by the Gnangara pine plantation and Whiteman Park (Government of Western Australia 2011). The remainder of the catchment has been cleared for residential, rural and industrial uses.

Surface water and wetlands present within the ERB are generally associated with the intersection of groundwater with the ground surface in interdunal swales or depressions. Some wetlands may also be perched groundwater in areas of low permeability where underlying clays, peats or iron-cemented sands create a confining layer. Some of the most significant surface water features in the ERB are Bennett Brook and its associated wetlands chains, and Horse Swamp, a CCW located west of Bennett Brook and north of Marshall Road (refer to Chapter 4.4.2 for definition of wetland categories). These are depicted in Figure 4-1.

Bennett Brook is a slow flowing stream, approximately 17 km in length, with a catchment of 217 km^2 (Coffey 2015d). The Brook retains a natural channel form through the ERB and supports environmental values including riparian vegetation and fauna habitat. The waterway is also associated with significant Aboriginal cultural values (discussed in Chapter 5).

Bennett Brook originates in Whiteman Park as a superficial groundwater aquifer, which rises and feeds wetlands during winter months. Bennett Brook flows south and discharges into the Swan River at Success Hill, Bassendean (Government of Western Australia 2011). Historically it has flowed from early August until early November, depending on seasonal rainfall conditions (SERCUL 2013). Groundwater pumping for metropolitan water supply in the northern extent of the Bennett Brook catchment has lowered groundwater levels and in turn, reduced flow into Bennett Brook.

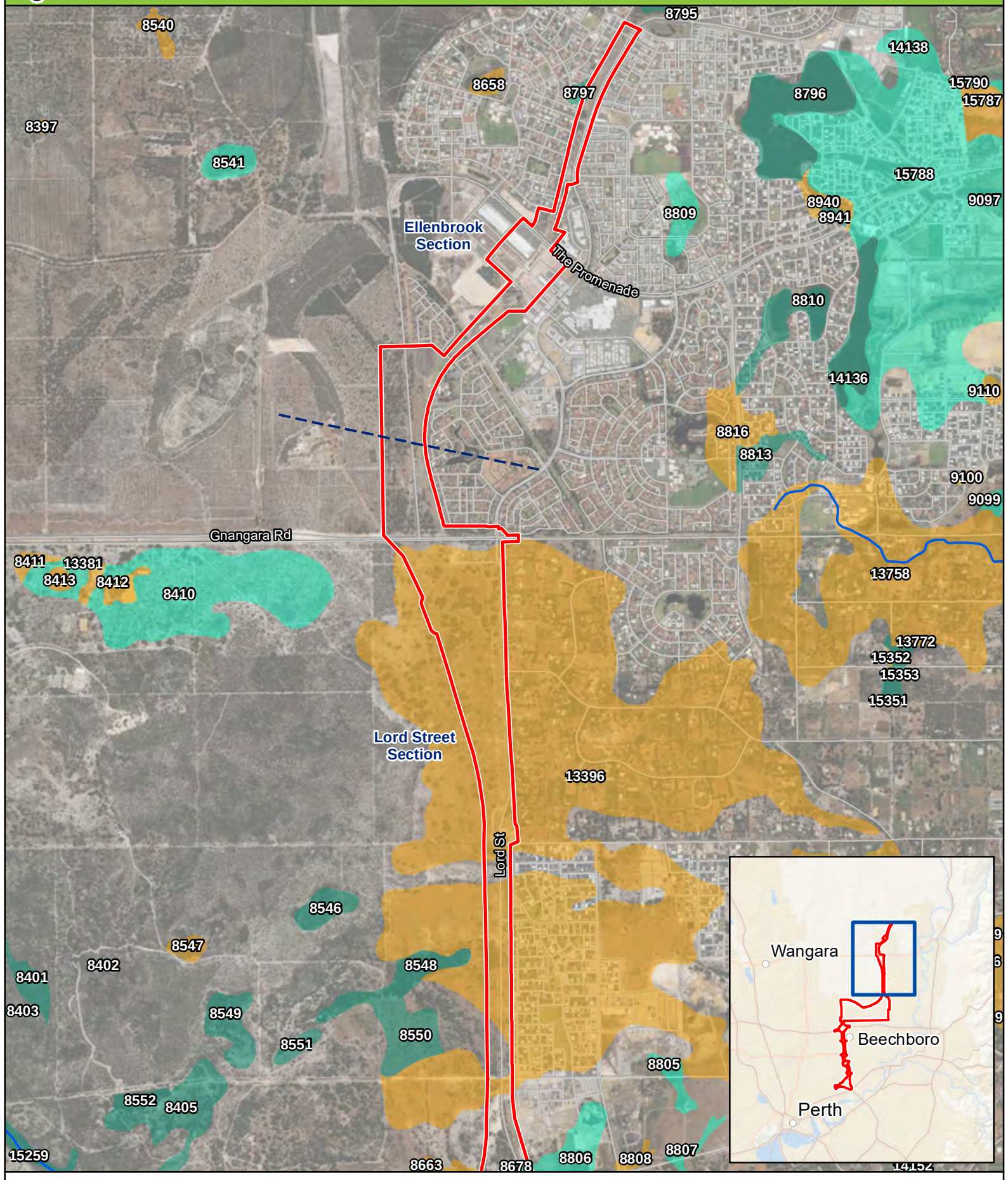
Monitoring of water and sediment quality was conducted annually in Bennett Brook from 2003 over a period of at least 12 years approximately 1.5 km south (downstream) of its intersection with the ERB.

The annual monitoring events record exceedances of criteria for pH, electrical conductivity, total suspended solids, nutrients and metals (SERCUL 2013). This monitoring aims to help locate pollution hotspots throughout the Bennett Brook catchment that may contribute to contamination in Bennett Brook and the Swan River (Government of Western Australia 2011).

In the southern portion of the Bennett Brook catchment, increased runoff has resulted in higher than natural flow (DoW and DPAW 2015). No specific flood studies for Bennett Brook were available for review, however the 100 year ARI floodplain development control area associated with the Brook extends approximately 350 m on either side of the Brook through the ERB, indicating a requirement for floodplain management.

In addition to the natural system comprising the Bennett Brook, a constructed open water drain (Water Corporation Emu Swamp main drain), located north of Marshall Road and west of Beechboro Road North, intersects the ERB. The drain conveys stormwater from a substantial area of residential development in Ballajura in an easterly direction and does not have capacity to accommodate additional stormwater (RPS 2015).

Figure 4-1a: Surface water features



Legend

- Environmental review boundary
- Major waterway

Geomorphic Wetlands (UFI displayed)

- Conservation
- Resource Enhancement
- Multiple Use
- Not Applicable

0 250 500 1,000
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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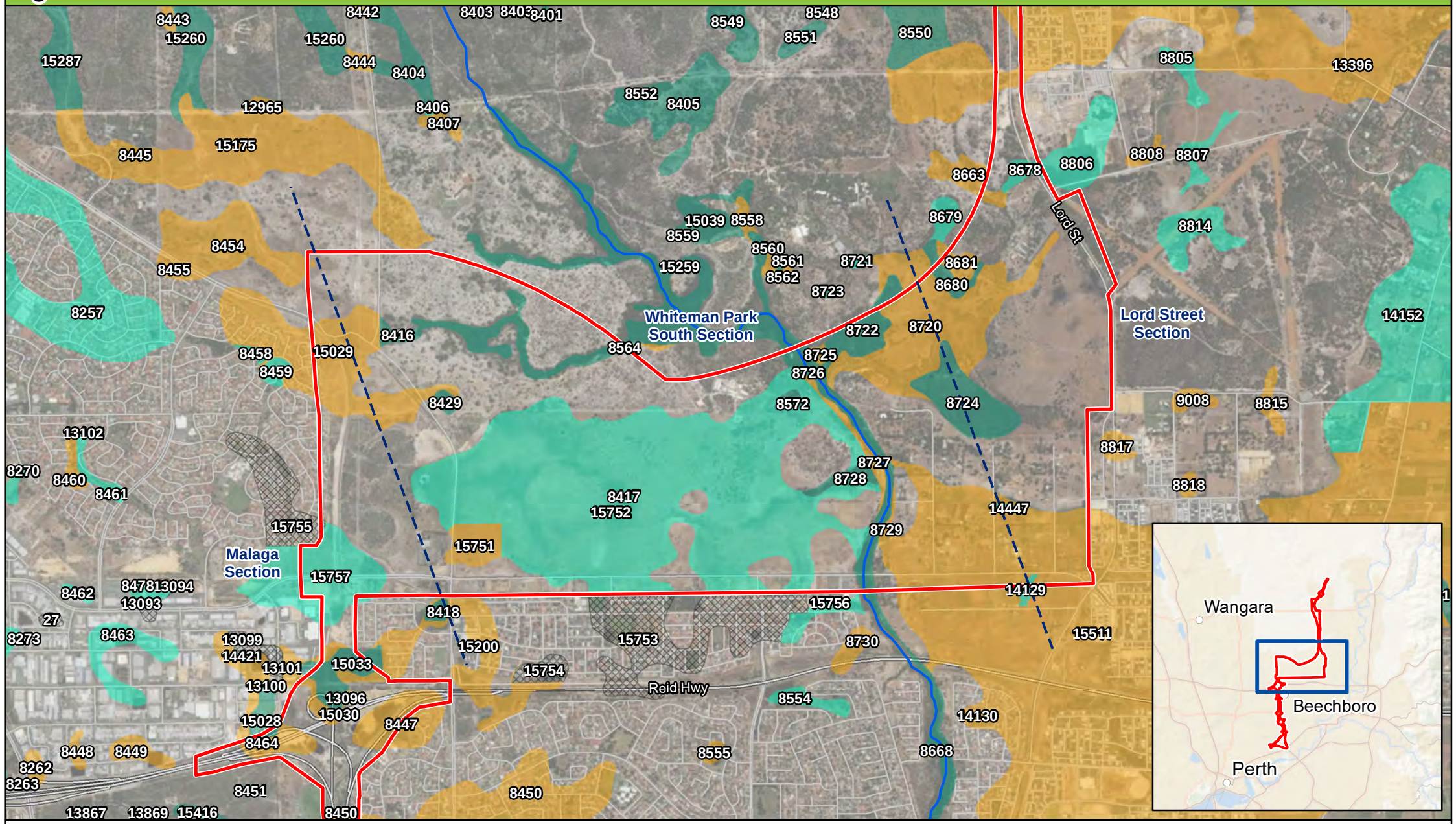
Figure 4-1b: Surface water features



Legend

- Environmental review boundary
- Major waterway

Geomorphic Wetlands (UFI displayed)

- Conservation
- Resource Enhancement
- Multiple Use
- Not Applicable

0 250 500 1,000
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

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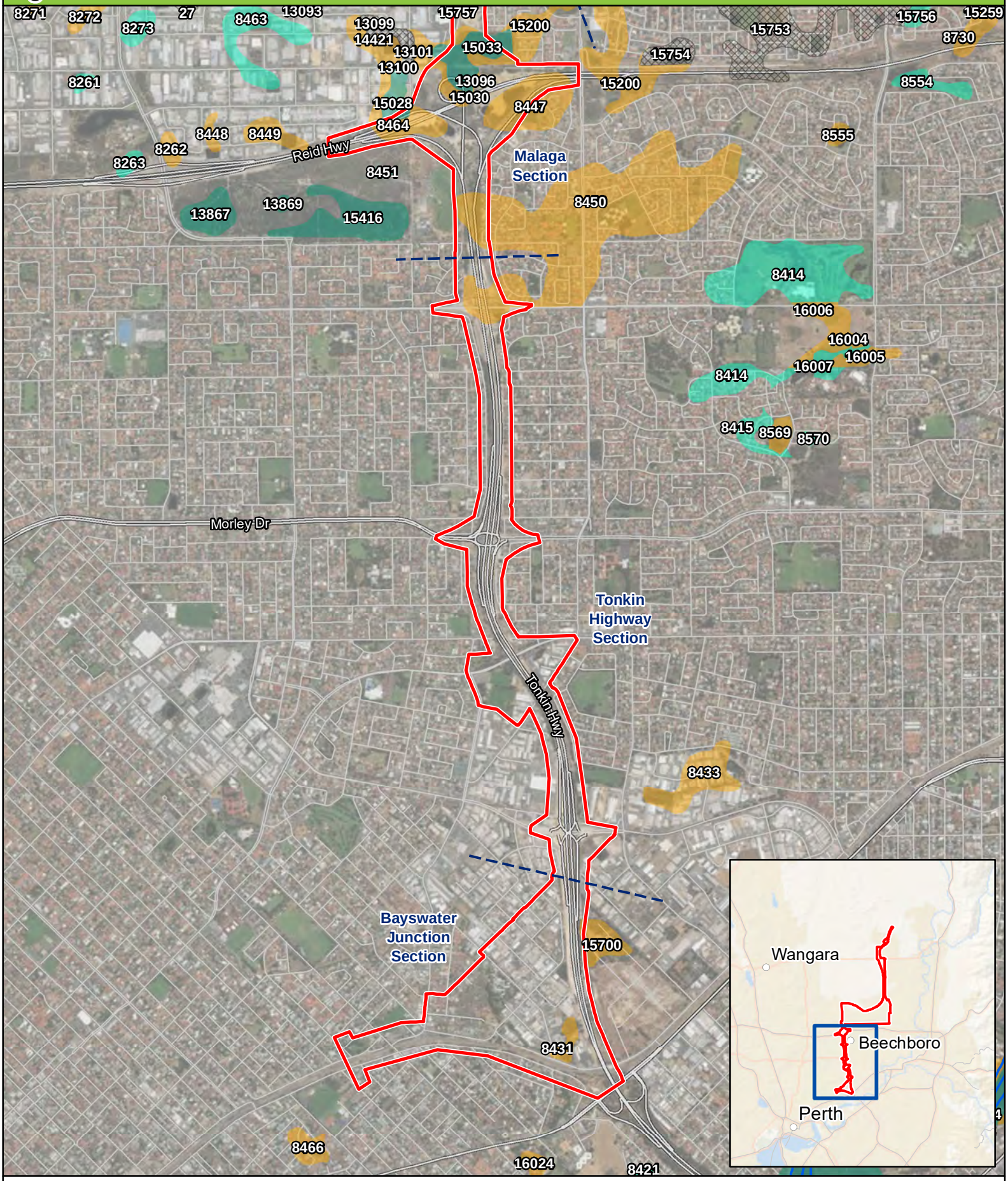
Prepared by: SM Date: 19/03/2019

Figure 4-1c: Surface water features



Legend

- Environmental review boundary
- Major waterway

Geomorphic Wetlands (UFI displayed)

- Conservation
- Resource Enhancement
- Multiple Use
- Not Applicable

0 250 500 1,000
Metres
Datum/Projection:
GDA 1994 MGA Zone 50

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4.3.2 Geomorphic wetlands

Due to a large portion of the ERB being located within a portion of the Swan Coastal Plan classified as a palusplain (seasonally waterlogged flats), there are extensive wetland features located within the Malaga, Whiteman Park South, Lord Street and Ellenbrook sections of the ERB.

None of the identified wetlands are nationally or internationally important wetlands. The nearest nationally important wetland (Ellen Brook Swamps System) includes Ellen Brook Swamp and Twin Swamps, which are located approximately 4 km to the east and more than 6 km north-east of the ERB, respectively.

CCWs are those which support a high level of attributes and functions. REWs may have been partially modified but still support substantial ecological attributes and functions. Multiple use wetlands (MUW) have few remaining important attributes and functions (DPaW 2018).

A search of Landgate's Geomorphic wetlands of the Swan Coastal Plain database (15 February 2019) identified 13 CCWs, 6 REWs and 20 MUWs wetlands intersecting the ERB. Conservation significant wetlands (CCWs and REWs) are identified in Table 4-2 and wetland mapping is provided in Figure 4-1.

Table 4-2: Summary of conservation significant wetlands intersecting the ERB

UFI	Conservation status	Wetland type	Wetland name (if named)	Desktop observations
8572	Conservation	Palusplain		
15028	Conservation	Sumpland	Victoria Road Swamp	Appears to have been cleared and filled for development and no longer a wetland
8726	Conservation	Lake	Mussel Pool	
8728	Conservation	Palusplain		
8680	Conservation	Palusplain		
8797	Conservation	Dampland		Appears to have been filled for urban development and no longer a wetland
15033	Conservation	Sumpland	Victoria Road Swamp	75% of wetland to be impacted by PDNH and remainder already cleared
8417	Conservation	Palusplain		
15259	Conservation	Floodplain	Bennett Brook	
8724	Conservation	Sumpland	Horse Swamp	
8416	Conservation	Palusplain		
8429	Conservation	Sumpland		
8722	Conservation	Palusplain		
14129	Resource enhancement	Palusplain		
15757	Resource enhancement	Sumpland		36% of wetland to be cleared by PDNH and remained assumed to be significantly impacted
14447	Resource enhancement	Palusplain		
8806	Resource enhancement	Palusplain		

UFI	Conservation status	Wetland type	Wetland name (if named)	Desktop observations
8678	Resource enhancement	Sumpland		
15752	Resource enhancement	Palusplain		In a 2013 clearing application (CPS 5492/1-withdrawn) RPS concluded that where this wetland occurs on Lot 99 (the majority) it is more consistent with a Multiple use category wetland classification.

No CCWs or REWs are located within the Bayswater Junction or Tonkin Highway sections of the ERB. One small CCW (UFI 8797) is mapped in the Ellenbrook section of the ERB though, based on an assessment of aerial photography, it appears to have been cleared and filled as a result of urban development and is likely no longer a wetland. All remaining CCWs and REWs within the ERB occur within the Malaga, Whiteman Park South and southern portion of the Lord Street sections of the ERB. Impacts to two of these CCWs comprising Victoria Road Swamp (UFI 15033 and 15028) and one REW (UFI 15757) in the vicinity of the Tonkin Highway and Reid Highway intersection have been approved by the EPA in association with the PDNH project. Based on aerial photography, the combination of the PDNH project plus impacts due to urban and industrial development appear to have resulted in complete loss of the Victoria Road Swamp CCWs.

Of regional significance is Horse Swamp (UFI 8724), a CCW and part of Bush Forever Site no. 304, located in the southern portion of Whiteman Park and entirely within the ERB (Figure 4-1). An Environmental Management Plan (Cook 2011) was developed for this wetland in 2011 to advise Whiteman Park management and staff about issues affecting the Swamp and to recommend management strategies. Horse Swamp has been subject to substantial historical clearing; however, still has significant ecological value. It covers approximately 19 ha with the boundary defined by a constructed walking path. Horse Swamp is very flat and is dominated by palusplain. The surface is waterlogged and is flooded in winter, dry in summer, though the water table remains close to the surface year-round. Salt is present on the surface of the lowest sections of the swamp. In the south-west of the site, the landscape rises slightly into a dryland environment (Cook 2011).

4.3.3 Groundwater

4.3.3.1 Aquifers

A hydrogeological assessment undertaken for NorthLink identified three aquifers present in the development envelope relevant to that project, including the Mirrabooka, Leederville and Yarragadee aquifers (Coffey 2015b). These are overlaid by superficial formations including the transmissive Bassendean Sand deposits which comprise a superficial aquifer. The thickness of the superficial aquifer ranges between 30 m and 55 m with an average of approximately 35 m (DWER 2018). The hydraulic conductivity of the Bassendean Sand ranges between 10 m/day and 50 m/day (MRWA 2015).

4.3.3.2 Groundwater levels and direction

Groundwater levels are consistently shallow across the ERB. The Perth groundwater atlas shows groundwater at or near the ground surface through parts of the Whiteman Park South section of the ERB, increasing in depth along parts of Tonkin Highway and Ellenbrook, with maximum depth to groundwater of approximately 11 m. The groundwater is generally 3 m to 10 m below the ground surface.

Given the unconfined nature of the superficial aquifer, groundwater levels change with seasonal rainfall patterns and recharge is rapid (Coffey 2015b). Groundwater monitoring conducted on a quarterly basis for the NorthLink project indicates groundwater levels peak during winter and are at a minimum during summer, with seasonal variations of up to 3 m (Golder 2017).

Groundwater generally flows from the Gnangara Mound (refer to Section 4.4.3.3) in an easterly to southerly direction, with groundwater discharging to Ellen Brook to the east or Swan River to the south (Coffey 2015b).

4.3.3.3 Groundwater dependent values

Due to the relatively shallow groundwater levels within the ERB, groundwater is responsible for supporting a range of environmental values. As a groundwater fed stream, groundwater levels are ultimately responsible for defining the hydrologic regime of Bennett Brook (discussed in Section 4.4.1), a waterway that supports significant cultural, ecological and amenity values. Groundwater is also responsible for supporting wetland values within the ERB (apart from where wetlands may be perched) and GDEs, as discussed in Section 2.3.3.

4.3.3.4 PDWSAs

The groundwater of the superficial aquifer is of considerable importance to local users and the Perth region as a whole. The Gnangara groundwater mound is a proclaimed PDWSA, shown in Figure 4-2. Priority areas within the PDWSA are defined to guide land use decision making. The ERB intercepts the Priority 1, 2 and 3 areas. Train lines are acceptable or compatible with conditions in all priority areas, however associated infrastructure and development such as station precincts may not be. Railway stations are incompatible with Priority 1 and 2 areas and compatible with conditions in Priority 3 areas.

This PDWSA supplies more than 40% of the water supply to the Integrated Water Supply Scheme and is the most significant source of groundwater for the Perth region (DWER and WC 2017). This water source is used to support domestic, environmental, recreational, commercial (horticulture and agriculture) and industrial needs (Coffey 2015b).

Wellhead protection zones are designated in association with water abstraction points within PDWSAs. Six wellhead protection zones intersect the ERB, located within the Malaga, Whiteman Park South, Lord Street and Ellenbrook sections. The locations of these wellhead protection zones suggest that there is one production bore located within the ERB. Special protection measures apply in wellhead protection zones as described in the By-laws under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909*.

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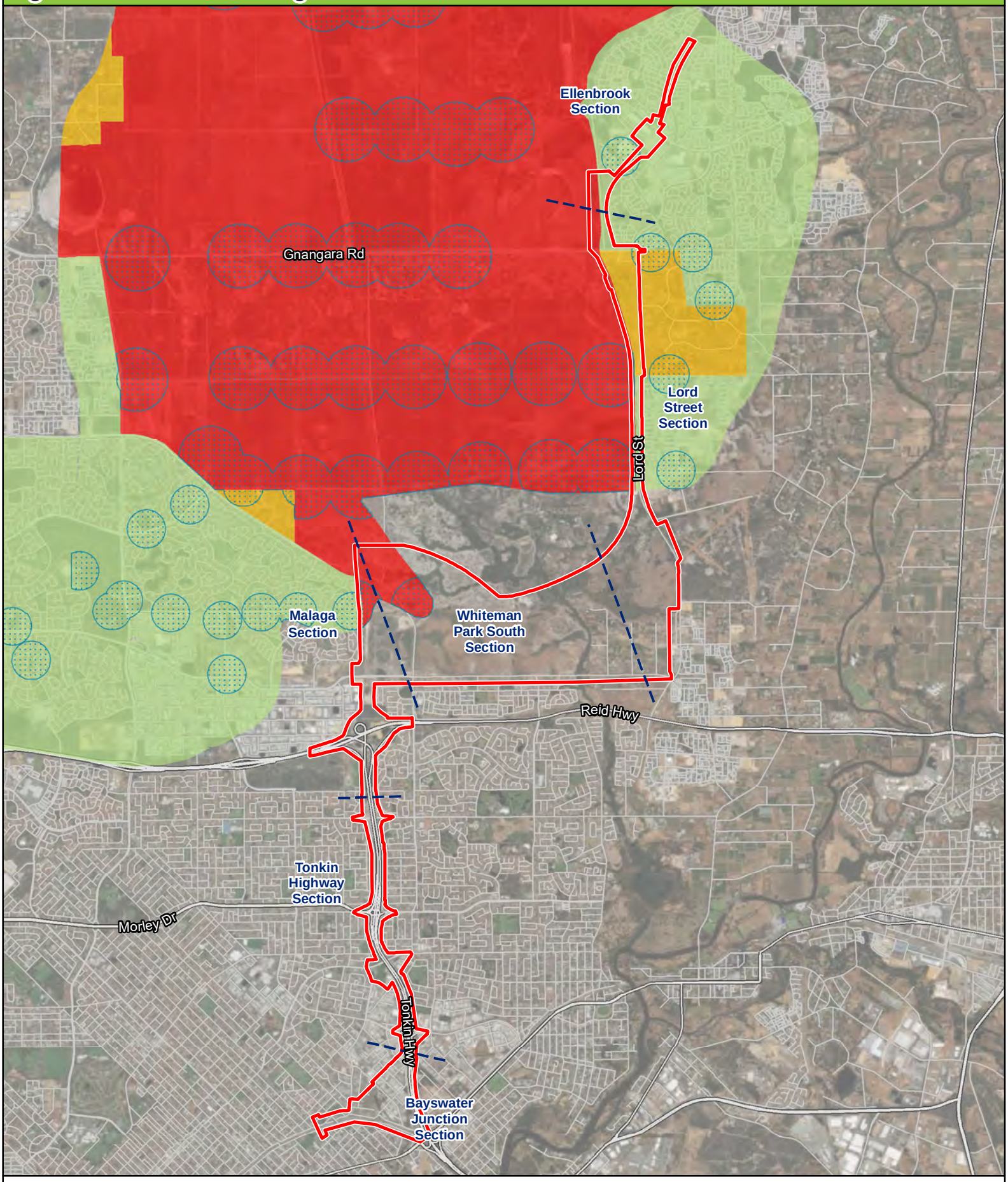
Figure 4-2: Public drinking water source areas



Legend

- Environmental review boundary

Public drinking water source areas

- Priority 1
- Priority 2
- Priority 3
- Wellhead protection zone

0 0.5 1 2
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

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4.3.3.5 Groundwater quality

The NorthLink study found groundwater in the region is generally acidic with pH ranging from 4 to 6. The calcium carbonate content of Bassendean Sands is low and offers little acid buffering capacity. Nutrient levels vary and are influenced by land use (Coffey 2015b).

Groundwater quality within the ERB is expected to be influenced by existing and historic land uses, local geology, recharge and discharge zones and seasonal fluctuations in groundwater levels. Groundwater quality in the wider superficial aquifer is typically good, with salinity generally increasing, but remaining low, further from the crest of the Gnangara Mound which is located approximately 15 km north of the ERB (Coffey 2015b).

A number of contaminated sites and associated contaminant plumes are known to occur intersecting or in proximity of the ERB (see Chapter 5), including the former CSBP fertiliser site at Bayswater. These sites are generally located in the southern portion of the ERB where land use intensity has historically been higher.

Acid sulfate soils are also known to occur within the ERB (see Chapter 5 for further discussion). These soils have potential to impact on groundwater quality and associated values where the soils are exposed to air as a result of excavation of groundwater drawdown.

4.4 Potential constraints

Based on the review of the information available to inform this desktop review, surface and groundwater attributes of the ERB are expected to form some of the most significant potential environmental constraints on the MEL project. Hydrological regimes within the ERB are known to support a range of related values including flora and vegetation associated with wetlands and riparian areas, fauna habitat, Aboriginal cultural values and public drinking water supplies.

Key constraints associated with inland waters include:

- 10 Conservation category wetlands, with four small Resource Enhancement wetlands also requiring further consideration;
- Bennett Brook and its associated foreshore and floodplain
- Shallow groundwater tables supporting groundwater dependent vegetation
- Impacts to groundwater quality from known and potential acid sulfate soils and contaminated sites

As the ERB is located in an area of palusplain dominated by surface features such as wetland and waterways, careful consideration of the potential impacts of the MEL project on these features will be needed. A detailed understanding of surface water behaviours, including flooding regimes of the catchments that intersect the ERB will need further investigation, particularly when determining and designing construction levels of critical infrastructure, maintaining predevelopment flow paths and volumes and incorporating pollution controls.

Water quality and potential impacts of the project on general hydrological functioning of Conservation category wetlands will be a significant consideration. Four small Resource enhancement wetlands (UFIs 8806; 8678; 14129 and 14447) may also require further consideration. Detailed assessments of the

potentially affected waterways and significant wetlands will be required to provide adequate baseline data of their attributes and to inform design, impact assessment and mitigation and management responses. Definition of wetland boundaries and foreshore areas may also be required as part of this process and will also inform any requirement for licences under the *Rights in Water and Irrigation Act 1914* (RIWI Act) to interfere or obstruct the bed and banks of a wetland or watercourse.

Surface water quality management will also be a key consideration for all waterway crossings, including but not limited to Bennett Brook and its tributaries.

Due to shallow groundwater tables, the intersection between surface water and groundwater is likely to be an important consideration in planning and management of the MEL project, as well as ecological and cultural values supported by groundwater. A comprehensive understanding of the local and regional groundwater minimum and maximum levels will be critical in determining the impact of the project on groundwater regimes. As peak groundwater levels are expected to be highly responsive to seasonal variation, it is critical that a robust monitoring program is in place to obtain relevant data specific to the project area.

Approval to take water under the RIWI Act may be required for bore construction and groundwater abstraction if groundwater is to be abstracted for the project. Any required abstraction of groundwater for construction or operation purposes will need to consider potential groundwater drawdown impacts to any GDEs (refer to Chapter 2) and existing production bores within the ERB. The project's potential impacts on the Priority 1, 2 and 3 PDWSA's will also require further investigation and characterisation.

Acid sulfate soils (ASS) and contaminated sites are likely to require further investigation and definition, in line with the Department of Water and Environmental Regulation (DWER) ASS guidance and the *Contaminated Sites Act 2003* respectively, in order to ensure risk can be adequately identified and managed to prevent impacts to water quality. Disturbance for sub-surface infrastructure such as shallow underground services and deeper dive structures for underground tunnels may present a risk of disturbance or migration of contamination within the ERB where dewatering is required.

Description of values supported by hydrological regimes presented in this Chapter is confined to the boundary of the ERB. In addition, no detail was available on the likely location or extent of dewatering or abstraction in relation the MEL project. It should be noted that any proposal for groundwater abstraction and/or drawdown relating to construction of the MEL project may need to consider values beyond this boundary. It is not currently possible to determine where potential for impacts exists outside of the ERB.

5. Terrestrial Environmental Quality

The EPA defines Terrestrial Environmental Quality as "the chemical, physical, biological and aesthetic characteristics of soils". This environmental factor recognises the fundamental link between soil quality and the protection of ecological and social values that good soil quality supports, focusing on how changes to soil quality impact on environmental values. In line with this, the EPA's environmental objective for the factor Terrestrial Environmental Quality is "to maintain the quality of land and soils so that environmental values are protected".

This chapter provides information relating to terrestrial environmental quality within the ERB and identifies associated potential constraints to the MEL project.

5.1 Relevant guidance

The following policies and guidance are relevant to terrestrial environmental quality:

- Environmental Factor Guideline: Terrestrial Environmental Quality (EPA 2016g)
- Assessment and Management of Contaminated Sites (DER 2014)
- Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (DER 2015).

5.2 Information sources

5.2.1 Databases searches

The following database searches were undertaken to support this analysis:

- Australian Soil Resource Information System (ASRIS) Database – Soils Database
- DWER – Contaminated Sites Database
- DWER – Perth Groundwater Atlas
- Landgate Shared Locations Information Platform (SLIP) – Environmental Database

5.2.2 Reports provided by the PTA or publicly available

Table 5-1: Key reports reviewed relevant to terrestrial environmental quality

Title	Author	Year	Summary of scope relevant to Terrestrial Environmental Quality
PSI Perth–Darwin National Highway (PDNH), NorthLink	Coffey	2015	A PSI into the potential sources of contamination that may be encountered within the boundary of the PDNH. Included reporting of site observations, potential receptors, conceptual site models, ASS risk mapping, Contaminated Sites Database search, DWER records search and previous investigations.

Title	Author	Year	Summary of scope relevant to Terrestrial Environmental Quality
PSI on Contamination Tonkin Grade Separation Project	360 Environmental	2014	A PSI into the potential sources of contamination that may be encountered within the boundary of the Tonkin Grade Separation Project. Included review of and exposure pathways for the following contaminates sites: • Tonkin Highway Reserve • Former Cresco/CSBP Site Bayswater • Former Metal Recycling Facility • Former Service Station – 335 Collier Road Bassendean • Former CSBP Site Bassendean • Former Motor Vehicle Workshop – Jackson Street Bassendean • Former Pest Control Depot – 20 Bassendean Road Bayswater
MEL Options – Environment and Heritage Assessment Morley to Ellenbrook Route Protection Study	Jacobs	2018	A feasible options assessment for the MEL route, based on an investigation of heritage and environment within the proposed MEL envelope.
Preliminary ASS Investigation Perth-Darwin National Highway, NorthLink	Coffey	2015	A detailed PSI into the potential for ASS within the boundary of the PDNH including consideration of construction methodology, potential impacts, sensitive receptors and risk assessment comprising: • Risk of acid sulfate soil occurrence • Risk of acid generation • Dewatering risk
Perth Airport Rail Link Preliminary Site Investigation	GHD	2013	Investigation into potentially contaminating land uses, probable nature of contaminants and likely presence of ASS within the Airport link alignment.
PSI Former Liquid Waste Disposal Facility, Lexia	Golder Associates	2015	A PSI was undertaken at the former liquid waste disposal facility, located in Lexia WA. The Site is classified as '*Possibly Contaminated – Investigation Required*'.

5.2.3 Information coverage

The Tonkin Highway section of the ERB, and a portion of the Malaga section were included within the study area of a Preliminary Site Investigation undertaken by 360 Environmental for the Tonkin Grade Separation Project (2014b). In addition, terrestrial environmental quality has been considered at different levels of detail for parts of the alignment covered by various preliminary site investigations for contamination, ASS investigations, due diligence reports and environmental impact assessments (Coffey 2015e,f Jacobs 2018; GHD 2013; Golder 2015).

Regional information and the above listed reports provide an overview of terrestrial environment quality across the ERB. However, there has been no comprehensive assessment of the location and extent of potential contaminants across the ERB that have potential to impact on terrestrial environmental quality.

5.3 Description of relevant environmental values

5.3.1 Soil and Surface Geology Mapping

Soils across the ERB are typically expected to consist of Bassendean Sands overlying Guildford Clays. Bassendean Sands typically consist of white to grey quartz sand, with minor fines content and negligible clay content. They are recognised by the DWER as being of particular concern regarding ASS, as they are devoid of carbonate minerals and may contain highly reactive pyrite (DWER 2014). Low lying areas, such as those within the northern half of the ERB (north of Reid Hwy) are likely to have accumulated alluvial sediments with varying organic content and may contain peaty material.

The southern portion of the ERB, within the area of the Tonkin Highway intersection, show a similar geology, predominantly comprising of Bassendean Sands from the Bassendean and Southern River sandplains (Coffey 2015e). The Southern River sandplains consist of low sand dunes, with iron and humus podzols, peats and clays occurring in low lying areas.

5.3.2 Acid Sulfate Soils risk

A review of publicly available data relating to ASS within the vicinity of the ERB was undertaken to identify the risk of ASS occurrence. A review of the Australian Soil Resource Information System (ASRIS, 2014) database indicates the following (Figure 5-1):

- The majority of the ERB is mapped as *low probability* of occurrence within the top 3 m of soil.
- Small areas within the ERB are mapped as *high probability* of occurrence within the top 3 m of soil.

The disturbance of potential ASS material in high risk areas may lead to the production of sulfuric acids and mobilisation of metals and nutrients in soil and groundwater resulting in changes to surface and groundwater quality or habitat degradation. Actual or potential ASS can also result in risks to infrastructure and human health (DWER 2014).

ASS within the ERB are associated with the superficial geological and hydrogeological formations consisting primarily of the Bassendean Sand unit which unconformably overlies the Guildford Formation, the primary geological units found within the ERB (360 Environmental 2014b; Coffey 2015f).

The Bassendean Sand unit is highly leached and contains no buffering capacity to neutralise the formation of acid and acid by-products which can form on oxidation of the material. At the zone of groundwater fluctuation within the Bassendean Sands, the formation of ferruginous podzols known as Coffee Rock horizons are present and can be a major contributor to elevated iron concentrations in groundwater (Davidson 1995).

The Guildford Clays which are present in places at shallow depths beneath the Bassendean Sand and, based on studies in and around the ERB, are known to be acid generating in nature. The clay forms a semi-confining layer within the superficial aquifer and is discontinuous in nature. Exposure of the Guildford Clay and potential oxidation during excavation and dewatering activities presents a risk of acid generation during construction activities (Coffey 2015e; Jacobs 2018).

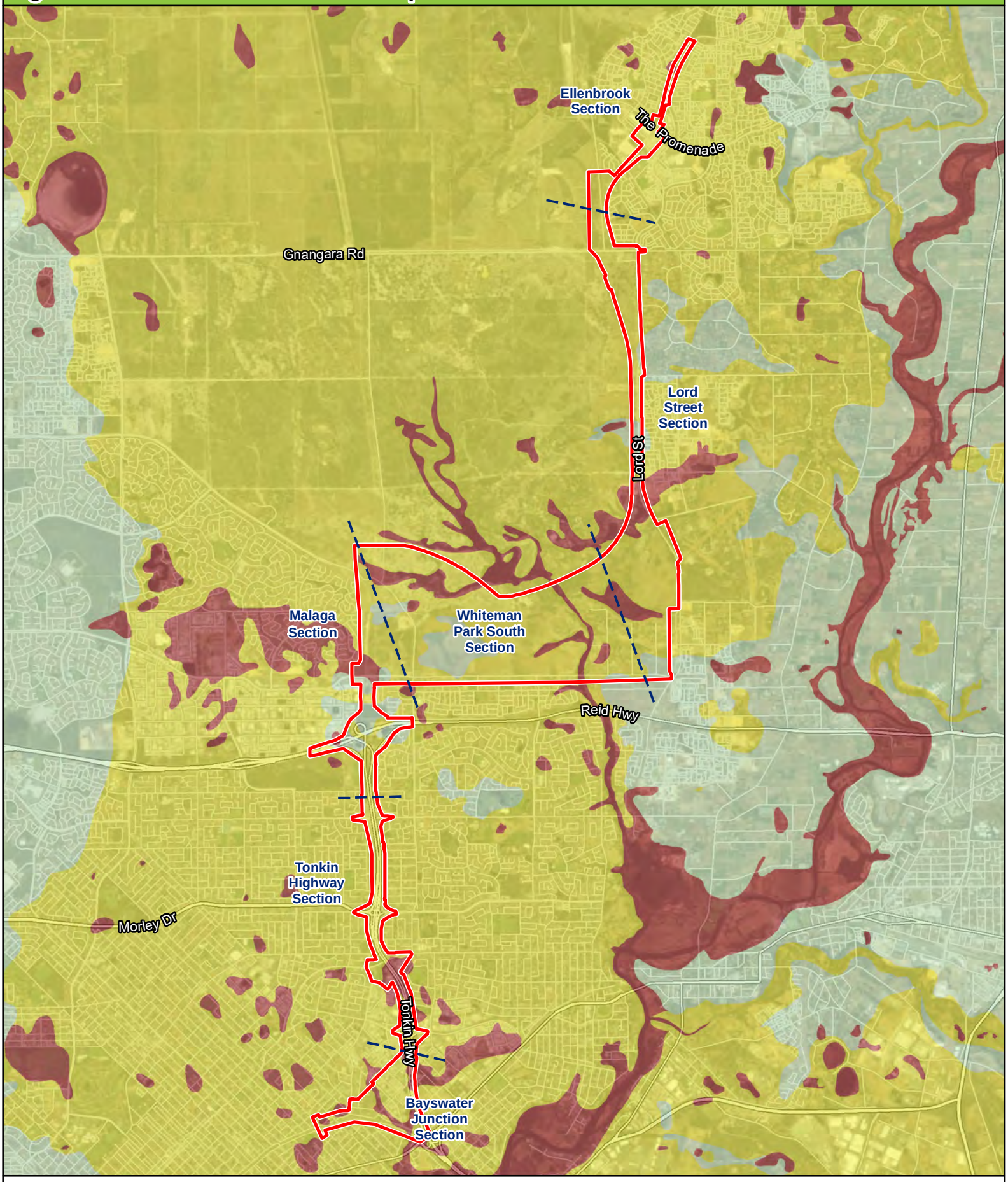
Within the northern half of the ERB, areas where there is a *high probability* of occurrence are generally limited to small low lying areas (Jacobs 2018). Isolated peaty deposits associated with humic wetlands

present a risk of net acid production from the oxidation of sulphide bearing minerals and organic materials, albeit the rate of generation is typically slower than that of the Bassendean Sand Unit.

Due to the developed nature of the ERB, significant infrastructure exists in some areas mapped as high probability of ASS occurrence such as along Tonkin Highway (360 Environmental 2014b). Associated excavation, removal of surface materials and placement of fill is likely to have changed the nature of the surface soils. This may result in an overestimate of surface ASS risk in some areas.

A high level review of various reports provided by the PTA was undertaken incorporating areas within the ERB, with results consistent with the finding of the above assessment.

Figure 5-1: Acid sulfate soil risk map



Legend

Environmental review boundary

Acid sulfate soils risk (ASRIS)

- High risk
- Low risk
- Extremely low risk

0 0.5 1 2

Kilometres

Datum/Projection:
GDA 1994 MGA Zone 50

N

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5.3.3 Contaminated Sites

A contaminated sites database search was undertaken to determine if any properties within the ERB have been classified under the *WA Contaminated Sites Act 2003* into any of the following categories:

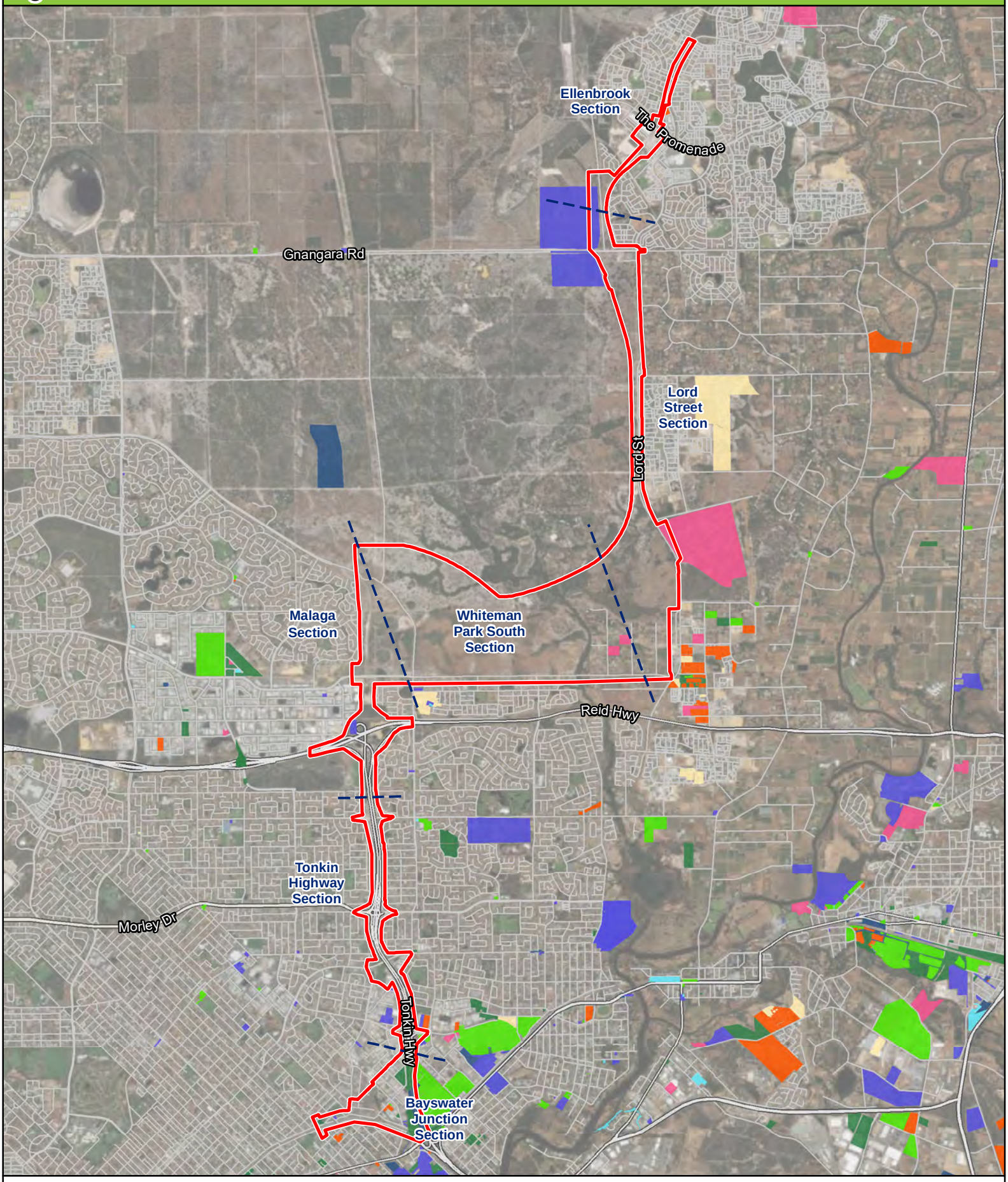
- Contaminated – restricted use (C-RU);
- Remediated for restricted use (RRU); or
- Contaminated – remediation required (CRR).

There are 24 registered classified sites on the database within the ERB with one of these classifications (DWER 2019). Details are summarised in Table 5-2. A number of additional sites were also identified within a 1 km radius of the ERB.

Table 5-2: Contaminated sites database search results

Classification	Identification	Location relevant to MEL	Reason for Classification
RRU	Lot 337 On Plan 3404	500m north-west of the Tonkin Highway / Railway Parade Intersection	Soils beneath the site are impacted by pesticides. The impacted soils are contained beneath bitumen and concrete hardcover. **Restrictions on land use:** Land use restricted to commercial / industrial Excavation of soils is prohibited without a health and safety management plan to manage exposure risks.
RRU	Lot 9 On Plan 33567	200m to the east of Tonkin Highway / Collier Road Intersection	Heavy metals and polychlorinated biphenyls exist in the soils along the perimeter of the site and in some soils under reinforced concrete on site. Quality of groundwater is unknown. **Restrictions on land use:** No groundwater abstraction to occur onsite without further groundwater assessment. Land use restricted to commercial / industrial
CRR Includes 22 individual lots, grouped together within 16 overarching lots	Lot 17 On Plan 5389 Lot 18 On Plan 5389 Lot 19 On Plan 5389 Lot 20 On Plan 5389 Lot 23 On Plan 5389 Lot 26 On Plan 5389 Lot 27 On Plan 5389, Lot 28 On Plan 5389 Lot 29 On Plan 5389 Lot 30 On Plan 5389 Lot 300 On Plan 41002 Lot 301 On Plan 41002 Lot 310 On Plan 9542 Lot 311 On Plan 9542 Lot 312 On Plan 9542 Lot 313 On Plan 9542	600m stretch of Tonkin Highway. From Railway Parade Intersection to Bassendean Rd	Arsenic, cadmium, chromium, cobalt, copper, lead, manganese, nickel and zinc contamination is present with soils within the area along the Tonkin Highway reserve from the intersection the Railway Parade to Bassendean Road located approximately 600m to the north, above ecological and human health criteria. Quality of groundwater is unknown. **Restrictions on land use:** Land use restricted to commercial / industrial. No groundwater abstraction to occur onsite without further groundwater assessment.

Figure 5-2: Contaminated sites



Legend

- Environmental review boundary

Contaminated sites

- Awaiting Classification
- Contaminated - remediation required
- Contaminated - restricted use
- Decontaminated
- Not contaminated - unrestricted use
- Possibly contaminated - investigation required
- Remediated for restricted use
- Report not substantiated

0 0.5 1 2
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

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Prepared by: SM Date: 16/04/2019

These sites are shown in Figure 5-2, along with locations of sites with the following classifications provided by PTA:

- Possibly contaminated – investigation required (PC-IR);
- Not contaminated – unrestricted use (NC-UU);
- Decontaminated; and
- Awaiting classification.

Based on the results above, soil impacts from known contaminated sites are limited to three broad areas along the ERB, all within the southernmost portion. All lots have a restriction to a commercial / industrial land use only, which would require that soils within these areas are suitably covered at all times to prevent exposure to soils (360 Environmental 2014b; DWER 2019).

The quality of the groundwater beneath all the above Sites, within the exception of Lot 337, was noted as being unknown at the time of assessment. The current status of Lot 337 as of May 2013 indicated that the groundwater was free of pesticide contamination (360 Environmental 2014b). A high level review of various reports provided by the PTA was undertaken incorporating areas within the proposed ERB, with results consistent with the finding of the above assessment (360 Environmental 2014b; Coffey 2015e; Jacobs 2018). A number of additional matters were identified during this review which may require further investigation, including but not limited to:

- Potential unexploded ordinance risk at Lot 800 Youle-Deane Road Brabham;
- Use of Lot 99 Whiteman Park as a soil treatment facility for the Elizabeth Quay development; and
- Suspected asbestos containing material at various locations.

A clearing application and site management plan for the soil treatment facility at Lot 99 Whiteman Park have been reviewed. These documents identify a Closure Report to be provided to DWERs contaminated sites branch at the cessation of works. In the absence of the site's identification on the contaminated sites database it is assumed that work did not result in any contamination issues, however this should be confirmed as part of broader contamination investigations.

Based on the outcomes of a Preliminary Site Investigation (PSI) undertaken by Golder Associates in March 2015, a former Liquid Waste Disposal Facility (LWDF) in Lexia was classified as *'Possibly Contaminated – Investigation Required'*. This site is located 400m to the west (outside) of the ERB. In respect to possible soil impacts at the former LWDF, it is considered unlikely that this would create a negative impact to soil quality within the ERB, given the distance to the ERB boundary. However, due to the geological nature of sandy soils, and the direction of groundwater flow, it is considered possible in the absence of any known groundwater investigations post-1994, that heavy metal and nutrients impacts may extend underneath the north-western portion of the ERB.

5.4 Potential constraints

The presence of known acid sulfate soils and contaminated sites within the ERB represents a potential constraint to the MEL project. Potential exists for impacts to terrestrial environmental quality through disturbance of these areas and will require thorough investigation.

Due to the anticipated depth of disturbance for construction activities associated with MEL it is expected that disturbance of ASS will occur within the superficial formations which extend on average to a thickness of 30 m and will be most pronounced at deeper dive structures where major soil disturbance and potential dewatering will be required to facilitate excavation activities. Where not appropriately managed, acid sulfate soils have potential to impact on terrestrial environmental quality an could result in impacts to groundwater and habitat degradation.

ASS risk mapping is generally based on landforms, with high risk areas typically correlating with current or former surface water systems and wetlands. The risk maps are designed to be used for broad-scale planning purposes and are not intended to provide site-specific ASS information. Further detailed mapping of potential and actual ASS will be required to inform excavation and dewatering management.

There is a total of 24 known contaminated lots within the southern portion of the ERB;

- one lot located 500 m north-west of the Tonkin Highway / Railway Parade intersection;
- one located lot 200 m to the east of Tonkin Highway / Collier Road intersection; and
- one area comprising 22 lots, located within the 600m stretch of Tonkin Highway, north of Railway Parade.

Additionally, there are areas within the ERB classified as '*Possibly Contaminated – Investigation Required'* (PC-IR). Based on information provided by PTA, the former LWDF in Lexia has been identified as a PC-IR site which may have impacted groundwater quality beneath the north-west portion of the ERB. An additional site with this classification is located within the Reid Highway, Tonkin Highway interchange.

Prevention of contamination migration will need to be considered where excavation or dewatering is proposed in the vicinity of known or potential contaminated sites. The requirement for treatment and/ or disposal of contaminated or potentially contaminated materials could present a constraint to the project.

6. Social Surroundings

The EPA Act describes Social Surrounds as; "the social surroundings of man are his aesthetic, cultural, economic and social surroundings to the extent that those surroundings directly affect or are affected by his physical or biological surroundings*"*.

This means, any environmental impact that has the potential to cause a subsequent impact on a person's aesthetic, cultural, economic or social surroundings value may be considered significant. In line with this description, the EPA's environmental objective for the factor *Social Surroundings* is "to protect social surroundings from significant harm".

This chapter provides information relating to social surrounds within the ERB and identifies associated potential constraints to the MEL project.

6.1 Relevant guidance

The following policies and guidance are relevant to the Social Surroundings factor:

- Environmental Factor Guideline: Social Surroundings (EPA 2016h)
- State Planning Policy 5.4 Road and Rail Transport Noise and Freight Considerations in Land Use Planning (WACP 2009)
- Mechanical vibration and shock – Evaluation of human exposure to whole-body vibration (Standards Australia 2018)
- Rail Infrastructure Noise Guideline (EPA 2013)
- Visual Landscape Planning in Western Australia Manual (WACP 2007)
- A Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Sites Remediation and Other Related Activities (DEC 2011)

6.2 Information sources

6.2.1 Reports provided by the PTA or publicly available

Key reports reviewed in relation to the environmental factor of Social Surroundings are summarised in Table 6-1.

Table 6-1: Key reports reviewed relevant to social surroundings

Title	Author	Year	Summary of scope
Morley to Ellenbrook Route Protection Study, MEL Option 2 Environment and Heritage Assessment	Jacobs	2018	Report detailing the environmental and heritage constraints associated with MEL alignment Option 2 (MCA Enhanced Option A) including four registered sites of Aboriginal Heritage. No sites of European Heritage identified.
Desk-Top Aboriginal Heritage Analysis of Proposed Morley to Ellenbrook Railway Line	R. & E. O'Connor Pty Ltd	2018	Preliminary Aboriginal Heritage assessment of the proposed alignment involving a search of the Register of Aboriginal Sites. Six registered Aboriginal Heritage sites found to intersect the ERB, with one further site within 100 m.

Title	Author	Year	Summary of scope
Whiteman Park Conservation and Environmental Management Plan	Whiteman Park	2018	A strategic plan for the management of Whiteman Park's natural environment, aiming to support current management initiatives and to identify areas of conservation value that require ongoing management. Whiteman Park contains 5 registered sites of Aboriginal Heritage as well as various recreational pursuits, including Horse Swamp, Werillyiup Walking Trail, Bennett Brook and a constructed bird hide.
Report on a Desktop Aboriginal Heritage Assessment of the Whiteman Park South Project Area	Ethnosciences	2017	Desktop assessment to determine whether the Whiteman Park South region contains any registered Aboriginal Heritage sites which might influence any planning decision or development, and to assess the potential for currently known sites or other values to be present. Identified two registered ethnographic sites intersecting the project area. No archaeological sites identified, however recognised a high archaeological potential for artefact scatters.
Ellenbrook Bus Rapid Transit, Environmental Impact Assessment and Environmental Management Plan	Aurecon	2016	Assessment of the potential impacts of the EBRT project and potential management measures that may be required. Requirement of further assessments is also discussed. Potential impacts of dust, noise and vibration are discussed. Identified five registered Aboriginal Heritage sites located within the ERB, and no sites of European Heritage found. Three places of potential Visual Amenity located surrounding the ERB.
Addendum: Report on Aboriginal Heritage Survey for Site ID 551 Lord Street North 1, Whiteman Park, Western Australia	Brad Goode & Associates Consulting Anthropologists & Archaeologists	2016	Report outlining the additional consultation for Site ID 551 following a brief provided by Main Roads Western Australia regarding the submission of a s18 application to the Department Aboriginal Affairs (DAA) on 21 July 2016 for the proposed ERBT project. Concluded the details provided in a previous 1995 survey and the 1995 s18 ministerial conditions were consistent with the fenced location within proximity to Lord Street representing the actual location of Site ID 551.
West Ellenbrook Engineering Servicing Report, September 2016	Cossill & Webley Consulting Engineers	2016	Summarises the results of a preliminary assessment of the engineering aspects of the proposed urban development of West Ellenbrook. Identified the Banksia Woodland Revegetation Research Area as a potential conservation amenity constraint.
Transportation Noise Assessment, NorthLink WA-Southern Section, Guildford Road to Reid Highway, 100% Design Submission Report	Lloyd George Accoustics	2016	A noise assessment undertaken for the NorthLink project including predicted noise levels to sensitive receivers and the appropriate mitigation to achieve the proposed targets. Predicted, using traffic volumes estimated for 2040, that the proposed mitigation is deemed acceptable to ensure the proposed noise criteria are met.

Title	Author	Year	Summary of scope
Report of an Ethnographic Aboriginal Heritage Survey of the Proposed NorthLink WA Project Part 2: Perth-Darwin National Highway	Amergin Consulting	2015	Desktop assessment and an ethnographic field survey/consultation to identify any known or previously unreported ethnographic sites within the NorthLink WA Project Area. Four registered Aboriginal Heritage sites identified as intersecting the NorthLink development corridor.
A Report on the Archaeological Assessment of the NorthLink WA Project (Perth-Darwin National Highway)	Snappy Gum Heritage Services	2015	Archaeological investigation and assessment of the NorthLink WA Project area. Ground surface variability for the NorthLink alignment was low, with the most common land-use activity noted to be pastoral.
Report of an Ethnographic Aboriginal Heritage Survey of the Proposed NorthLink WA Project Part 1: Tonkin Grade Separations	Amergin Consulting	2015	Desktop research and ethnographic field survey/consultation of the proposed Tonkin Grade Separations, which form part of the NorthLink WA Project.
Due Diligence Risk Assessment Advice for the Proposed Lord Street Busway, from Bennett Springs to Ellenbrook, Western Australia	Brad Goode & Associates	2015	Assessment to provide advice regarding the risk of a Section 17 breach of the AHA occurring should works on the Lord Street Busway proceed as they were planned. Five registered sites of Aboriginal Heritage identified, with an additional two lodged sites located within the development corridor.
Public Environmental Review Perth-Darwin National Highway (Swan Valley Section)	Coffey	2015	Public Environmental Review to be used by the Office of the Environmental Protection Authority and the Department of the Environment as the basis for conducting an environmental impact assessment for the Perth-Darwin National Highway Identified the following constraints relating to the ERB: • Amenity (noise and vibration) and potential sensitive receptors • Two registered sites of Aboriginal Heritage • No sites of European Heritage • One recreational reserve amenity
NorthLink WA: Air Quality Assessment	Pacific Environment Limited	2015	Assessment on impacts to air quality in relation to the NorthLink Project. Identified potential sensitive receptors and the recommendation of a Dust Management Plan to be implemented as it is difficult to quantify dust emissions from construction activities. Any effects from dust concluded to only have temporary and relatively short-lived effects and only in dry conditions with winds in a particular direction.

Title	Author	Year	Summary of scope
Forrestfield-Airport Link Noise and Vibration Management, Construction and Operation Environmental Impact Report	SLR	2015	Assessment of the noise and vibration impacts expected with the construction and operation of the Forrestfield-Airport link project. concluded that most construction activities are expected to exceed project vibration and noise goals, without mitigation. Implementation of mitigation resulted in predicting operational vibration and noise levels to be compliant to current standards.
Report of an Aboriginal Heritage Desktop Assessment of the NorthLink WA Project (Perth-Darwin National Highway)	Amergin Consulting	2014	Aboriginal and European heritage investigations in relation to the NorthLink WA Project involving desktop research and field surveys Identified five places of Aboriginal Heritage within the ERB.
Report of an Aboriginal Heritage Desktop Assessment of the NorthLink WA Project (Perth-Darwin National Highway) Incorporating the Proposed Swan Valley Bypass and Tonkin Grade Separations	Amergin Consulting	2014	Aboriginal and European Heritage investigations in relation to the NorthLink WA Project Two registered sites of Aboriginal Heritage identified, with four lodged places of Aboriginal Heritage (based on current listings of Aboriginal Sites).
Study of Groundwater-Related Aboriginal Cultural Values on the Gnangara Mound, Western Australia	Estill & Associates	2005	Study conducted on the Aboriginal cultural values associated with groundwater-related environmental features and processes on the Gnangara Mound. Examined the significance of groundwater-related sites for Aboriginal people and recommendations regarding avoidance of negative impacts on water dependent Aboriginal cultural values.

6.2.2 Information coverage

Due to the urban and infrastructure development of the surrounding area, various studies on the social surroundings of the ERB have been conducted, with the majority related to the approval of the NorthLink project and identification of the associated environmental constraints of this project. Many of the studies conducted for NorthLink are relevant to the ERB.

The majority of the information available from current literature is an assessment of the Aboriginal and European Heritage present within the area. Information on these matters was found to be comprehensive, covering the entirety of the ERB, with no additional database searches deemed to be required for the purpose of this literature review. It should be noted that while previous reports/surveys have indicated the presence of a value, as a result of the project's implementation, these values may no longer be present. Further verification of presence/ absence may be required at a later date.

Some information is available relating to amenity values within the ERB, in particular relating to Whiteman Park and the recreational values found within this area. This information can be found in both management plans for this area, and the Whiteman Park dedicated website.

Some information relating to potential sensitive receptors (for noise, vibration and dust) within the ERB is available as a result of impact assessment undertaken for the NorthLink, FAL and the ERBT projects. While these studies are able to provide contextual information about the effects of the noise, vibration and dust, the impacts of noise, vibration and dust are usually project specific.

6.3 Description of relevant environmental values

The southern end of the ERB, including the Bayswater Junction, Tonkin Highway and Malaga sections, are located within highly developed areas creating a potential for a high number of sensitive receptors along the edge of the ERB. The northern portion of the ERB, including the Lord Street and Ellenbrook sections, is anticipated to be a major centre of urban growth in the northeast of the Perth metropolitan region (Coffey 2015b). This area with currently undisturbed locations could contain areas of potential archaeological significance, with considerations of future sensitive receptors also requiring recognition. The ERB additionally encompasses Whiteman Park, an area of high recreational and conservation value within the Perth metropolitan region.

Review of the information provided by the PTA in relation to the environmental factor of Social Surroundings has identified the following environmental values within the ERB, which may represent potential constraints to the project:

- six registered Aboriginal Heritage sites
- ten lodged Aboriginal Heritage sites
- 11 lodged European Heritage sites
- two recreational amenity values
- three potential visual amenity values
- possible sensitive receptors of noise and vibration and dust.

Aboriginal Heritage and the amenity value of Whiteman Park are areas of key consideration relating to the Social Surrounds factor for the MEL project. These environmental values have cultural significance, not only for Aboriginal peoples but for all Australians, and social significance in the way these locations are used by people. The current information available for each of these relevant environmental values is discussed further below.

6.3.1 Aboriginal Heritage

The ERB is located on a combination of alluvial soils and Bassendean sands which has been identified as having the potential for higher numbers of archaeological sites than other areas of the Swan Coastal Plain (Coffey 2015b). Numerous studies have been conducted within the MEL alignment from various projects undertaken in the surrounding area, with relevant consultation of local Aboriginal groups also conducted in order to adequately inform the impacts of these projects on Aboriginal heritage values. These studies taken in combination, provide a comprehensive description of the potential Aboriginal and European Heritage values applicable to the MEL project. Consultation with local Aboriginal people is currently being undertaken by METRONET.

The ERB is located within an area that has been widely utilised by various families of the Whadjuk for many generations, resulting in various sites of aboriginal historic and cultural significance located within this area. Evidence of this use of the country by Aboriginal people in historic times is found in historical artefacts such as stone artefact scatters, flaked glass, clay pipes or matchbox and tobacco tins. Other

connections include the continuing use of bush resources such as medicinal plants and the transmission of cultural knowledge (Coffey 2015b). Some of the sites found within the ERB are associated with farm camps, burials, fringe camps, missions or other institutions now since closed. A total of six registered Aboriginal sites and ten lodged sites are found to intersect with the ERB, described in Table 6-2 and Table 6-3 (Jacobs 2018; R. & E. O'Connor Pty Ltd 2018).

All the Aboriginal values (traditional use and knowledge; historical associations; spiritual values etc.) are significant for Aboriginal people as each one is an integral element of their cultural identity. No one value can be ranked above another as each one constitutes a fundamental element of their past, present and future. Degradation of any one of these values represents a further erosion of Aboriginal identity and culture (Estill & Associates 2005).

6.3.1.1 Registered Aboriginal Sites

A total of six Registered sites of Aboriginal Heritage are found to intersect the ERB. These sites have special significance to Aboriginal people and provide an important link to their present and past culture. A basic description of each site is described in Table 6-2. Further descriptions and attributes of each registered site are found below.

Table 6-2: Registered Aboriginal sites found intersecting with the ERB

Site ID	Site name	Site type	Additional information
551	Lord Street North 1	Ceremonial	May have been disturbed in the extension of Lord Street.
552	Lord Street North 2	Ceremonial, Mythological, Water Source	May have been disturbed in the Lord Street Extension.
3692	Bennett Brook: in Toto	Mythological	Restricted site
3840	Bennett Brook: Camp Area	Artefacts/Scatter, Ceremonial, Fish Trap, Historical, Man-Made Structure, Mythological, Skeletal Material/Burial, Camp, Hunting Place, Plant Resource, Water Source	Restricted Site
3745	Mussel Pool	Mythological, Camp	
20058	Temporary Camp	Camp	Destroyed in the 1990s

SITE ID 551 – LORD STREET NORTH 1

This site is located alongside Lord Street at the eastern edge of Whiteman Park. Described as a stand of paperbarks and Tea-trees, this site is believed to be an old 'initiation ground'. The Tea-trees are said to be symbolic of the old people who used the meeting ground (R. & E. O'Connor Pty Ltd 2018). During the extension of Lord Street, associated with the ERBT project, part of the site was granted approval to be disturbed, on the condition that every endeavour was made to limit encroachment onto the site and the remaining portion be fenced with an appropriate memorialisation provided (Brad Goode & Associates, 2015). This has been completed, with representatives of the Aboriginal people of the area assessing this fenced location as consistent with details of the actual site location, and that as a cool shady place, the location was also consistent with use as a corroboree place (Brad Goode & Associates 2016).

SITE ID 552 – LORD STREET NORTH 2

Located further south along Lord Street, this site is described as a permanent pool surrounded by reeds, grass trees and paperbarks (R. & E. O'Connor Pty Ltd 2018). Site ID 552 is defined by a sacred fresh water source associated with the *Dugatch* (*Waugal*) dreaming (Brad Goode & Associates 2015). Consultation with relevant Aboriginal peoples have also identified this area as a possible Kangaroo Increase Site, important in maintaining the kangaroo population in the area (Brad Goode & Associates 2015). This site, during the Lord Street Extension, was not granted approval for disturbance and was recommended to be fenced. At the time, an 80 m buffer zone was proposed between the site and the road extension (Brad Goode & Associates 2015).

SITE ID 3692 – BENNETT BROOK: IN TOTO

The Bennett Brook: In Toto site is a restricted site which is recorded to include the Brook and the banks on either side. The site extends approximately 7 km from Bennett Brook and the Swan River converging at Mussel Pool in Whiteman Park, including a tributary of Bennett Brook (Amergin Consulting 2015). The entire brook is of significance to the Whadjuk people as it was formed by the *Waugul*, whose spiritual essence is believed to still exist there (Coffey 2015b). It is reported that Aboriginal groups would move along the reaches of Bennett Brook hunting and gathering food while moving from camps in the Guildford area to Lake Gnangara and beyond (Whiteman Park 2018).

The spiritual and cultural health of Aboriginal people is considered to be dependent on the health and vitality of living water, stemming from a close connection to country which is difficult for many non-Aboriginal people to appreciate or even understand (Estill & Associates 2005). Bennett Brook is recognised by the Aboriginal people as a 'living water' source, and thus has special significance associated with it.

SITE ID 3745 – MUSSEL POOL

Located within Whiteman Park, intersecting marginally with the northern extent of the ERB, this site is described as a pool no more than 100 m long surrounded by an extensive swamp system (R. & E. O'Connor Pty Ltd 2018). This site is reported to have contained a camping area on the north-eastern side of the pool and was formed by the creative actions of the *Waugul*, whose spiritual essence still exists there (R. & E. O'Connor Pty Ltd 2018).

SITE ID 3840 – BENNETT BROOK: CAMP AREA

This site is held under Restricted Access in the Register; and as such, the exact location of the site is not publicly available. The publicly available indicative buffer zone intersects the ERB between Hepburn Avenue and Lord Street within Whiteman Park. The total area recognised publicly as Site ID 3840 encompasses an area from Whiteman Park to Benara Road between Hepburn Avenue and West Swan Road (R. & E. O'Connor Pty Ltd 2018). The actual extent of the northern section of this site, however, was described by R. & E O'Connor in a 1984 study as having '*Benara Road as its southern boundary, Patricia Street extension as its northern boundary, Bennett Brook as its eastern boundary and Lord Street as a notional western boundary*'. Based on this reported information regarding the site boundary, the actual extent of the site is likely to be located outside of the ERB (R. & E. O'Connor Pty Ltd 2018).

SITE ID 20058 – TEMPORARY CAMP

This site, according to the register, is located within the Tonkin/Reid Highway interchange, and no evidence of this camp remains today (Amergin Consulting 2015). Previous consultation with Aboriginal

people identified this camp as merely an occasional camping ground and could not be seen as an area of significance on the grounds of sentimental or other associations (R. & E. O'Connor Pty Ltd 2018; Amergin Consulting 2015).

6.3.1.2 Lodged Aboriginal sites

A further ten sites of Aboriginal Heritage are lodged with the DAA, but do not fit the criteria of a registered site (see Table 6-3). These sites have undergone varying levels of disturbance and degradation due to localised developments and potentially little of these sites remain. Most of these sites were associated with artefacts or scatters, with any signs of artefacts collected at the time of recording (Amergin Consulting 2015; Ethnosciences 2017). In previous reports, some of these sites were listed as "registered" under the AHA Act, however recent studies have downgraded them to "lodged" due to the level of disturbance of these sites. The classification within this document is the current listing of each of these sites of Aboriginal Heritage.

Table 6-3: Sites of Aboriginal Heritage lodged with DAA within the ERB

Site ID	Site name	Site type	Additional information
3178	Collier Road	Artefacts/Scatter	
3179	Clune Street	Artefacts/Scatter	All visible artefacts collected, and have since been disturbed/destroyed by development
3180	Marshall, Beechboro	Artefacts/Scatter	Disturbed by the construction of Marshall Road
3326	Bayswater 1-3	Artefacts/Scatter, Camp	Destroyed in the 1990s
3552	Marshall/Della Roads	Artefacts/Scatter	
3618	Whitemans Cutting	Artefacts/Scatter	Site heavily altered
3619	Whitemans Quarry	Artefacts/Scatter	
3749	Bayswater Camp	Camp	Destroyed in developments of adjacent industrial facilities.
4039	Broun Avenue	Artefacts/Scatter	All visible artefacts collected in the 1970s/80s and have since been disturbed/destroyed by development
21392	NOR/03 – Creek	Mythological, Camp, Meeting Place, Natural Feature, Water Source	

6.3.2 European Heritage

No State Registered sites of European Heritage are located within the ERB. Intersecting the ERB however, are 12 sites of European cultural significance that do not meet the criteria outlined in the *Heritage of Western Australia Act 1990*. Many of these sites may no longer exist, due to extensive disturbance and clearing practices within the area (Jacobs 2018). Within the City of Swan portion of the ERB, the Local Government lists Whiteman Park on the Municipal heritage register. All other sites within the ERB are on the Bayswater Municipal Inventory and are listed in Table 6-4.

Table 6-4: Places of European Heritage (not State Registered)

Site	Site name	Address
136	Bayswater Hotel	78 Railway Pde, Bayswater
11330	Mrs Keedwell's Drapery	67 Whatley Cr, Bayswater
25126	Dwellings – Attached	5 & 5A Rose Ave, Bayswater
11328	Corner Shop	20 Beechboro Rd South, Bayswater
11352	Century 21 Group of Shops	39 Whatley Cr, Bayswater
11269	House	102 Railway Pde, Bayswater
11303	House	15 Coode St, Bayswater
25127	Dwellings – Attached	16-18 Rose Ave, Bayswater
16863	Rail Line – Mathieson Rd	Mathieson Rd, Ascot
11351	Brady Plaster Works	12-26 Railway Pde, Bayswater
11334	Cresco Fertiliser works	2-4 Railway Pde, Bayswater

6.3.3 Amenity (Reserves and conservation areas)

6.3.3.1 Whiteman Park

Environmental values associated with Whiteman Park provide significant amenity value within the vicinity of the ERB. Whiteman Park is the largest recreation and conservation park in the Perth metropolitan region, covering an area of nearly 4,000 ha (Whiteman Park 2018). Originally used for the purpose of grazing cattle, Whiteman Park was created into a Public Open Space with the development of the popular picnic spot of Mussel Pool in the 1960s (Whiteman Park 2019). The creation of this parkland also served to protect the Gnangara Water Mound, a vital source of drinking water for the Perth metropolitan area and the creation of a safe haven for local flora and fauna. Whiteman Park now encompasses strong themes of education and conservation of environmental, transport and cultural heritage, through both the Park infrastructure, and the social value of the Park.

The ERB intersects the southern extent of Whiteman Park, from Hepburn Avenue to Lord Street. While much of the eastern edge has been mapped as completely degraded, the rest of the park contains further environmental value to people.

The environmental amenity value of Whiteman Park has been discussed in various aspects throughout reports and information publicly available through Whiteman Park's tourism information forums (Whiteman Park 2019). This information can be utilised to inform the possible impacts the MEL project will have on this area. Further information can be gathered from environmental impact assessments associated with the NorthLink project and management plans relating to different sections of the park and Whiteman Park as a whole. Recreational and social values attributed to Whiteman Park that are supported by the natural environment and are within the ERB are discussed below.

BENNETT BROOK

Bennett Brook originates in Whiteman Park as a superficial groundwater aquifer, and runs in a north/south direction through Whiteman Park and the MEL alignment. This aquifer, when recharged in rainfall events, supports the wetlands within Whiteman Park during the winter months (Whiteman Park

2019). These wetlands provide suitable habitat for many flora and fauna species enabling peoples' connection to the land and recreational pursuits of flora and fauna spotting and educational activities.

Whiteman Park, and surrounding areas, has high cultural significance for the Whadjuk people, with Aboriginal groups travelling along the reaches of Bennett Brook hunting and gathering food while moving from place to place within the Perth region. The Park has extensive wetland systems associated with Bennett Brook and its tributaries, and while specific sites are registered as protected with the DAA, the whole area has strong mythological and historical connections.

MUSSEL POOL

Located on the northern extent of the ERB within Whiteman Park, Mussel Pool is a popular scenic picnic area supporting various picnic shelters and playgrounds. Mussel Pool is also a popular setting for outdoor weddings. The Melaleuca Boardwalk has been created to support this purpose, and the aptly named Wedding Island is also located within this precinct.

HORSE SWAMP

Horse swamp is a natural ephemeral wetland usually dry for most of the year. This area supports many populations of waterbird breeding populations from July to October, providing bird watching opportunities with the aid of a constructed bird hide situated on the western edge of the Swamp. Stands of *Eucalyptus rudis* and *Melaleuca preissiana* at the eastern extent of Horse Swamp create favoured spots of some native animal species such as Kangaroos, affording fauna spotting opportunities within this area as well.

DOG PARK

Located in the Mussel Pool precinct of Whiteman Park, the Dog Park is a completely fenced off area of 2.5 ha surrounded by natural bushland and is a major recreational hub for pet owners. This site comprises drinking sources, agility equipment, seating, and over 500 m of walk path with entry free to this park.

BUSH WALKING TRAILS

Whiteman Park supports three bushwalking trails, two of which intersect the ERB encompassing Horse Swamp and parts of Bennett Brook. The Goo Loorto Trail traverses the western side of the Bennett Brook ending north of the Marshall Road fence-line. This trail boasts a permanent spring on the eastern side of the brook at the start of the trail, a large termite mound around the base of a Flooded Gum and a revegetated area originally created as a dam for watering cattle in the 1940s. The Werillyiup Trail is a 2.5 km loop encompassing Horse Swamp, with a constructed bird hide and lookout created along this trial to afford better interaction with the native landscape.

6.3.3.2 Banksia Woodland Revegetation Research Area

Also providing potential amenity value is a Banksia Woodland Revegetation Research Area within a Hanson Construction Materials Mining Lease area. This area is bound by Gnangara Road to the south, State Forest No. 65 to the north-west, and Drumpellier Drive to the east where it intersects the ERB. Hanson, in collaboration with the Botanic Gardens and Parks Authority, committed to attempting to return post-sand extracted sites within their tenement in west Ellenbrook to an ecosystem closely resembling the pre-disturbance *Banksia* woodland. This area has previously been identified as a valuable research asset (Cossill & Webley 2016). It is unclear exactly where within this tenement the

revegetation area occurs, however based on examination of aerial photography is appears likely that this is just outside the Ellenbrook section of the ERB.

6.3.4 Amenity (Noise, Vibration and Dust)

Currently, no studies are known to have been conducted on Noise and Vibration impacts on potential sensitive receptors associated with the MEL project. Environmental impact assessments conducted for the ERBT project, identified that existing traffic noise along Lord Street is already high (Aurecon 2016). This study predicted that by 2031 many noise sensitive receptors along Lord Street will be exposed to exceedances in noise levels related to road infrastructure alone. A similar study related to the NorthLink southern section (Guildford Road to Reid Highway) concluded that with the incorporation of noise barriers into the NorthLink project design, noise levels will comply with relevant standards (Lloyd George Acoustics 2016).

Environmental impact assessments conducted on similar projects (FAL) concluded that most construction activities are expected to exceed project vibration and noise targets, meaning that construction out of hours will require approval by relevant authorities and a comprehensive set of construction noise and vibration management plans for each site (SLR 2015). Operational vibration and noise levels were expected to be compliant to current standards with conventional/industry standard mitigation approaches incorporated into the design of the rail. These included techniques such as; rail fasteners, noise walls, track treatments, additional stack and plenum volumes, and distance from infrastructure.

It is often difficult to quantify dust emissions from construction activities as the generation of dust can vary from day to day, and be dependent on the operations undertaken, weather conditions, level of activity occurring within the development (Pacific Environment Limited 2015). Any effects of dust on environmental values tends to be temporary and relatively short-lived however and can usually be adequately controlled using mitigation techniques (Pacific Environment Limited 2015).

6.3.5 Amenity (Visual)

The topography of the landscape surrounding the ERB is typically flat, with undulating areas around Ellenbrook (Coffey 2015b). Visibility at ground level is noted to generally be low (between 0-50% visibility), with some open areas noted within Whiteman Park (Snappy Gum Heritage Services 2015).

To date, one report has identified potential visual amenity constraints applicable to the MEL project, originally created as an environmental impact assessment and environmental management plan for the ERBT project (Aurecon 2016). This impact assessment, aligning with the extent of Lord Street, identified three key locations within or in close proximity to Lord Street as potential Visual Amenity values:

- Ellenbrook City Centre;
- Ellenbrook Christian College; and
- Main eastern entrance to Whiteman Park

Other areas of note identified within the impact assessment by Aurecon (2016) include land zoned special use, or residential developments which abut extensive sections of the project footprint.

6.4 Potential constraints

Based on the information currently available, key constraints of the MEL project related to social surrounds include Aboriginal heritage sites and Whiteman Park amenity values (social, recreational and conservation).

The potential impacts of dust, noise and vibration to identified sensitive receptors has been shown to be adequately controlled in similar projects, and while likely to require mitigation and management are unlikely to present a major constraint to environmental approvals for the MEL project.

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7. Subterranean Fauna

The EPA defines subterranean fauna as, “fauna which live their entire lives (obligate) below the surface of the earth” being divided into two groups; Stygofauna, aquatic and living in groundwater, and Troglofauna, air-breathing and living in caves and voids.

The EPA’s objective of the factor Subterranean Fauna is “to protect subterranean fauna so that biological diversity and ecological integrity are maintained”.

This chapter provides information relating to subterranean fauna within the ERB and identifies associated potential constraints to the MEL project.

7.1 Relevant guidance

The following policies and guidance are relevant to the Subterranean Fauna factor

- Environmental Factor Guideline: Subterranean Fauna (EPA 2016i)
- Technical Guidance: Subterranean fauna survey (EPA 2016j)
- Technical Guidance: Sampling methods for subterranean fauna (EPA 2016k)

7.2 Available information

7.2.1 Datasets reviewed

The following dataset was reviewed for this assessment to provide information on potential subterranean fauna habitat within the ERB:

- Soil Landscape Mapping (DPIRD 2018).

7.2.2 Reports provided by the PTA or publicly available

Reports reviewed to provide information on subterranean fauna within the ERB are summarised below in Table 7-1.

Table 7-1: Key reports reviewed relevant to subterranean fauna

Title	Author	Year	Summary of scope
A review of subterranean fauna assessment in Western Australia: Discussion paper	EPA	2012	A review of existing subterranean knowledge and policy for Western Australia at the time of publishing and assessment of options for future impact assessment.
Groundwater Replenishment Scheme Stage 2: Subterranean Fauna Desktop Assessment	Bennelongia	2016	Review of the likelihood of stygofauna at a proposed groundwater recharge location, including a broad scale overview of stygofauna and preferred habitats on the Swan Coastal Plain.
Desktop review and desktop assessment of Subterranean Fauna for the Yanchep Rail Extension, Western Australia	Invertebrate Solutions	2018	An assessment of potential impacts to subterranean fauna as a result of the YRE project, including a broad scale overview of subterranean fauna on the Swan Coastal Plain.

7.2.3 Coverage of information

Whilst not specific to the ERB, the documents reviewed provide information on the general likelihood of occurrence of subterranean fauna and habitats on the Swan Coastal Plain, on which the proposed MEL is located.

7.3 Description of relevant environmental values

Subterranean Fauna usually have small distributions and do not move outside their specific habitats due to poor dispersal ability and the discontinuous nature of their habitats (EPA 2016i). This has resulted in high rates of endemism and as a consequence, they are particularly vulnerable to changes within local landscapes including changes to landforms, hydrological processes, inland waters quality and flora and vegetation. Suitable pores or voids are necessary to allow air or water to be present to support subterranean fauna (EPA 2016i).

Knowledge of subterranean fauna of the Swan Coastal Plain is relatively limited, however subterranean fauna specialists, Bennelongia and Invertebrate Solutions, consider that the Swan Coastal Plain region does not support stygofauna communities as diverse as the arid areas of Western Australia (Invertebrate Solutions 2018; Bennelongia 2016). The EPA notes that subterranean fauna are unlikely to occur in deep sands or clay geology (EPA 2016j), geologies that dominate the Swan Coastal Plain where the ERB is located. However, regional stygofauna sampling undertaken by Bennelongia did identify subterranean fauna within the superficial aquifer of the Gnangara Mound, albeit with low species richness (EPA 2012).

Groundwater habitats on the Swan Coastal Plain likely to support stygofauna include porous alluvium and colluvium, limestone karst, springs and the hyporheos of rivers and streams (Bennelongia 2016). Areas within the ERB consistent with these habitat descriptions include (Figure 7-1):

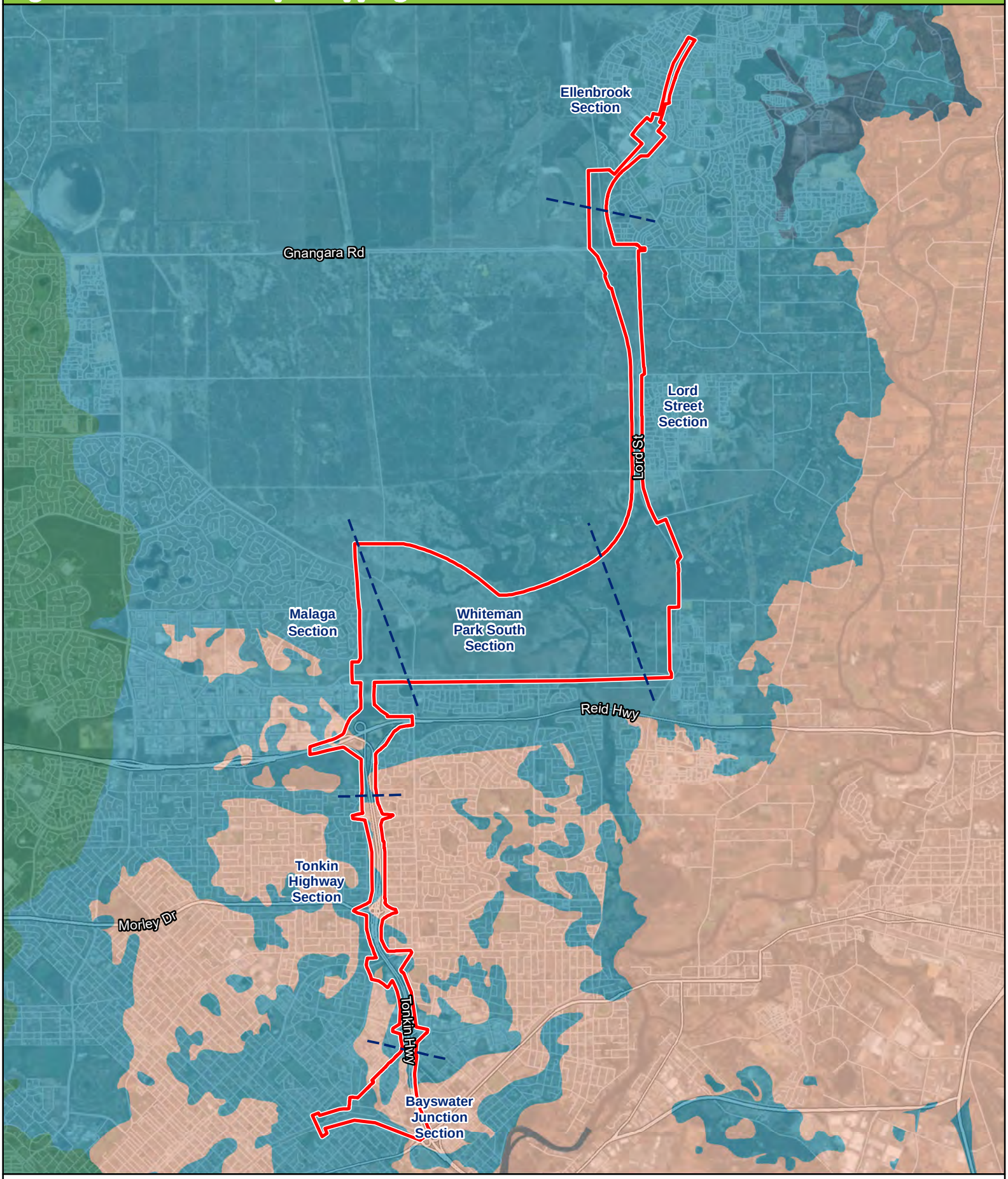
- The hyporheic zone (the area beneath and alongside the stream where there is mixing of shallow groundwater and surface water) surrounding Bennett Brook.
- Mound springs (discussed in Chapter 2).
- Porous zones within the alluvial Guildford formation underlying the Bassendean sands in parts of the ERB (noting that the Guildford formation generally has a high clay fraction and porous zones may be limited).

DPIRD soil landscape mapping shows Guildford formation (a component of the Pinjarra system) occurring intermittently within the Malaga, Tonkin Highway and Bayswater Junction sections of the ERB. However, various reports have also suggested its presence in the region between the Whiteman Park South and Lord Street sections.

Due to the nature of the aquifers in the region, and the fact that few of the species that have been identified are obligate subterranean species, few subterranean species on the Swan Coastal Plain are expected to have highly restricted distributions (Bennelongia 2016). Most stygofauna species with restricted distributions are expected to occur in association with landscape features, such as the Yanchep caves, rather than in the more hydrogeologically uniform parts of the Swan Coastal Plain (Bennelongia 2016), as expected in the ERB.

A combination of relatively shallow water tables and lack of air spaces within the Bassendean sand deposits that sit above the water table, mean that troglofauna are unlikely to occur within the ERB.

Figure 7-1: Soil landscape mapping



Legend

Environmental review boundary

Soil landscape mapping (DPIRD)

- Bassendean System
- Pinjarra System
- Spearwood System
- Yanga System

0 0.5 1 2
Kilometres
Datum/Projection:
GDA 1994 MGA Zone 50

N

www.ecoaus.com.au

Prepared by: SM Date: 21/03/2019

7.4 Potential constraints

The ERB contains groundwater habitats that are likely to support stygofauna within the hyporheic zone surrounding Bennett Brook, the mound spring areas and porous zones within the Guildford formation. Species richness across the Swan Coastal Plain is generally low with low likelihood of species with highly restricted distributions occurring. As such, subterranean fauna are unlikely to present a key constraint to the MEL project. However, any proposal to significantly alter the hydrologic regime within the ERB, such as through permanent drawdown of the groundwater table or contamination through disturbance of ASS or contaminated sites, in particular with relation to the Bennett Brook or mound spring communities, could impact on subterranean fauna and may require further consideration to determine significance.

8. Landforms

The EPA environmental objective of the factor Landforms is "to maintain the variety and integrity of significant physical landforms so that environmental values are protected".

The EP Act defines landforms as "the distinctive, recognisable physical features of the earth's surface having a characteristic shape produced by natural processes. A landform is defined by the combination of its geology (composition) and morphology (form)" (EPA 2018c). The environmental values associated with the environmental factor of Landforms include social, cultural, scientific, and ecological values.

This chapter provides information relating to landforms within the ERB and identifies associated potential constraints to the MEL project.

8.1 Relevant guidance

The following policies and guidance are relevant to the Landforms environmental factor:

- Environmental Factor Guideline: Landforms (EPA 2018c).

8.2 Information sources

8.2.1 Databases searches

The following dataset was interrogated to support this analysis:

- Soil Landscape Mapping (DPIRD 2018).

8.2.2 Reports provided by the PTA or publicly available

One report was reviewed to provide information on landforms within the ERB (Table 8-1).

Table 8-1: Key reports reviewed relevant to Landforms

Title	Author	Year	Summary of scope
Geology and landforms of the Perth region	Gozzard	2007	A guide to the landscapes and landforms of the Perth region, identifying geological history and natural features that characterise the region.

8.2.3 Coverage of information

Regional information is available to support a preliminary assessment of landforms in the ERB.

8.3 Description of relevant environmental values

Landforms are able to support numerous and varied environmental values including, but not limited to:

- Being a foundation for particular ecosystems
- Being sites of special scientific interest
- Representing examples of important physical landscape processes
- Embodying social and cultural values with strong historical or cultural associations.

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To guide its determination of the need for assessment of impacts to a particular landform, the EPA first determines whether the landform is a significant landform. Considerations can include (but are not limited to) variety, integrity, ecological importance, scientific importance, rarity and social importance of the landform (EPA 2018c).

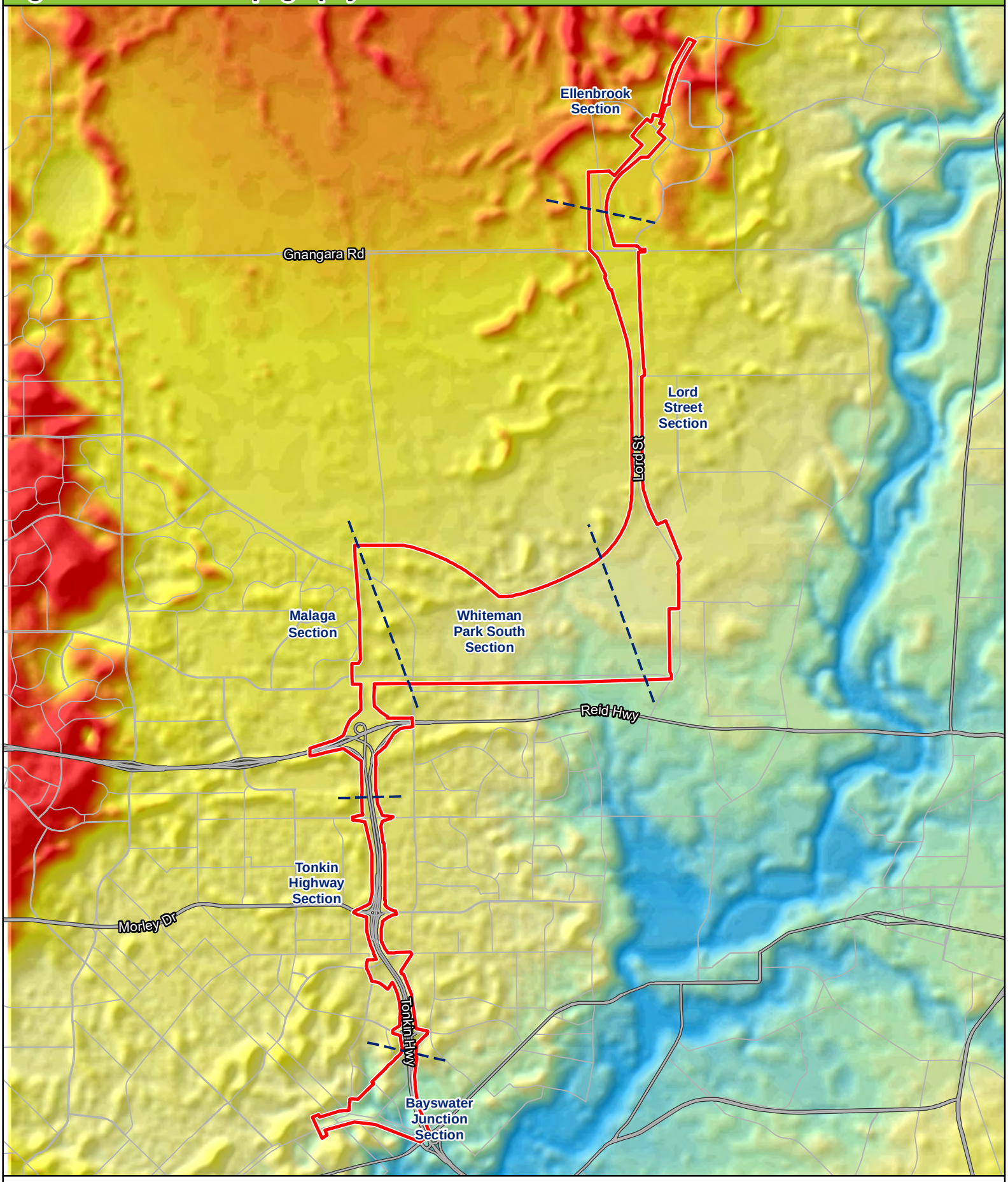
The ERB is located within the Bassendean dune system (Figure 8-1), an extensive system of shoreline deposits and coastal dunes running north-south and covering a 15 km wide zone of Perth Swan Coastal Plain (Gozzard 2007). The Bassendean dune system is relatively featureless in terms of topography, comprising low hills of unconsolidated sediments and sandy swamps between the dunes.

A number of ecological values are supported by the Bassendean dune system, including the Banksia woodlands of the Swan Coastal Plain TEC and wetland habitats (within dune swales). Whilst these values are present in parts of the ERB much of the landscape is cleared or highly disturbed.

Landforms across a large portion of the of the ERB (within the Bayswater Junction section, Tonkin Highway section and much of the Ellenbrook section) have been transformed due to urban and industrial development. The exception to this is through the Whiteman Park South and Lord Street sections of the ERB where topography remains largely unaltered. The landscape in this area is generally flat and dominated by palusplain, with scattered low hills of quartz sand comprising the Bassendean dunes.

The topography of the ERB is shown in Figure 8-1.

Figure 8-1: Surface topography



Legend

Environmental review boundary

Surface Elevation (m)

95m

47m

0m

0 0.5 1 2

Kilometres

Datum/Projection:
GDA 1994 MGA Zone 50

N

www.ecoaus.com.au

Prepared by: SM Date: 21/03/2019

8.4 Potential constraints

In considering potential impacts on landforms, the EPA first determines whether a landform to be impacted is a significant landform. The Bassendean dune system is extensive and well represented within the Swan Coastal Plain. Where the landform remains intact within the ERB, many of the ecological values its supports have been impacted by previous landuse.

Based on this assessment of the landforms present within the ERB, significant landforms are unlikely to be present; therefore, landforms are not expected to pose a key constraint with respect to the environmental approvals process for the MEL project.

This is consistent with the EPA assessments of the NorthLink, ERBT and FAL projects, which did not identify landforms as a key factor.

9. Commonwealth matters

The Commonwealth EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined as matters of national environmental significance (MNES). MNES protected under the EPBC Act with possible relevance to ERB are:

- Commonwealth-listed threatened species and ecological communities.
- Migratory species protected under international agreements.

The EPBC Act also provides for protection of the environment more generally where actions are proposed are on, or will affect, Commonwealth land and the environment. ELA has been advised that no Commonwealth lands are present within the ERB. As such, the following sections address relevant MNES only.

9.1 Relevant guidance

The following policies and guidance are relevant to MNES:

- Matters of National Environmental Significance: Significant Impact Guidelines 1.1 (DoE 2013)
- EPBC Act referral guidelines for three threatened Black Cockatoo species (DSEWPAC 2012)
- Guidelines for detecting orchids listed as 'threatened' under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia 2013)
- Approved Conservation Advice for the Banksia Woodlands of the Swan Coastal Plain ecological community (TSSC 2016)

9.2 Information sources

9.2.1 Databases searches

The following database searches were undertaken to describe the federal environmental values that that have the potential to be impacted by the MEL:

- DEE online EPBC Act Protected Matters Search Tool (PMST) using a 10 km buffered search area centred on the ERB (DotEE 2018a; Appendix B); and
- DBCA Threatened and Priority Fauna Database.

9.2.2 Reports provided by the PTA or publicly available

A summary of the previous investigations relevant to the ERB are outlined in Table 9-1.

Table 9-1: Key reports reviewed relevant to Commonwealth Matters

Title	Author	Year	Summary of scope
Flora and Vegetation			
Morley-Ellenbrook Line: Targeted *Caladenia huegelii* search 2018	RPS	2019	Reconnaissance search was undertaken of Banksia woodland vegetation at Fraser Road in Banjup to ascertain the emergence and flowering status of a large known population.
Detailed Flora and Vegetation Assessment	RPS	2019	Detailed (Level 2) flora and vegetation survey aimed to describe the flora and vegetation values of the ERB, determine their spatial location and conservation significance.
Waterbirds			
Waterbird survey and waterbird habitat assessment	RPS	In prep.	Waterbird assessment and field investigation for water sources within and surrounding the ERB. Preliminary findings are from 3 days in November 2018, with follow-up planned for early Spring 2019.
Fauna			
Level 1 Fauna Risk Assessment and Black-Cockatoo Habitat Assessment for the alternative Ellenbrook Rail Line Alignments of METRONET	Terrestrial Ecosystems	2018	Level 1 fauna risk assessment to identify threatened or priority vertebrate fauna likely to be in the Study Area. Included a Black Cockatoo habitat assessment.
Ellenbrook Bus Rapid Transit Biological Assessment	AECOM	2016	Level 1 fauna assessment including assessment of relevant MNES. Included a Black Cockatoo habitat assessment. No Threatened ecological communities or flora species were recorded. The Forest Red-tailed Black Cockatoo and migratory Rainbow Bee-eater were recorded during the field survey. Carnaby's Cockatoo and Baudin's Cockatoo considered likely to occur.
NorthLink WA Level 2 Targeted Fauna Assessment Perth-Darwin National Highway	Coffey	2015	Level 2 fauna assessment to identify and assess ecological values and significance, including fauna movement survey and a Black Cockatoo habitat assessment.
Public Transport Authority Forrestfield Airport Link Environmental investigation	GHD	2014	Level 1 fauna assessment to evaluate of the major environmental constraints in the Study Area. Included a Black Cockatoo habitat assessment.
Lot 800 Youle-Dean Road, Brabham – Black Cockatoo Habitat Assessment	PGV Environmental	2014	Black Cockatoo habitat assessment to update methodology and information provided in a 2007 ATA Environmental Carnaby's Cockatoo assessment.
Brabham LSP 3 Area – Black Cockatoo Habitat Assessment	PGV Environmental	2014	Black Cockatoo habitat assessment.
Black-Cockatoo Assessment – Tonkin Highway	360 Environmental	2013	Black Cockatoo habitat assessment of foraging and breeding habitat.

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9.2.3 Information coverage

The extent of coverage from previous investigations to define and assess MNES environmental values within the ERB is variable. The most continuous coverage provided by a single field survey was completed by AECOM (2016) for the ERBT Biological Assessment in February 2016, which covered approximately 150 ha of the ERB. The most recent survey effort was undertaken for the following reports, both of which cover a large portion of the northern half of the ERB where most remnant vegetation occurs:

- Detailed Flora and Vegetation Assessment METRONET Ellenbrook Alignment (RPS 2019a); and
- Level 1 Fauna Risk Assessment and Black- Cockatoo Habitat Assessment for the alternative Ellenbrook Rail Line Alignments of METRONET (Terrestrial Ecosystems 2018).

Targeted surveys for three EPBC Act-listed threatened flora species; *Caladenia huegelii* within remnant Banksia woodland in September 2018, *Conospermum undulatum* in October 2018 and *Trithuria occidentalis* in October 2018 have been undertaken throughout parts of the ERB comprising approximately 75 ha (RPS 2019a,b).

Given the recent nature of previous investigations (2013 to 2018), the information within the reports is generally sufficient for the identification of key values relating to the MNES within the ERB.

The ERB includes some areas that have not been considered in the abovementioned previous surveys, namely:

- The southwest corner of Whiteman Park, east of Beechboro Road North
- The southeast corner of Whiteman Park between Whiteman Drive East, Mussel Pool Road and Horse Swamp.

9.3 Description of relevant environmental values

The PMST database search identified the following MNES as having the possibility of occurring within 10 km of the ERB:

- Eight listed TECs
- 62 listed Threatened Species; and
- 44 listed Migratory Species.

These EPBC Act listed species and communities potentially occurring in the project area are further described in Sections 9.3.1 to 9.3.4.

9.3.1 Threatened ecological communities

Eight EPBC Act-listed TECs were identified in the PMST to occur within 10 km of the ERB. Three of these TECs were recorded or have potential to occur within the ERB (Table 9-2).

Table 9-2 lists TECs that were identified in the PMST and the likelihood of each species being present within the ERB, based on current records of habitat and distribution of each species and on-ground survey.

Table 9-2: TECs recorded or with the potential to occur the ERB

Name	Status	Likelihood of occurrence within ERB[1]
Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain	Endangered	**Unlikely.** This TEC was recorded within the ERB at three locations in Whiteman Park west of Lord Street by RPS (2019a). However, the DBCA has since advised that these occurrences do not meet the criteria for the TEC (English, pers. comm. 2018).
Banksia Woodlands of the Swan Coastal Plain ecological community	Endangered	**Known.** This TEC was recorded by RPS (2018a) in the Malaga, Whiteman Park South and Lord Street sections of the ERB. Two other locations were recorded outside the ERB.
Clay Pans of the Swan Coastal Plain	Critically Endangered	**Unlikely.** Not expected to occur within the ERB based on findings in previous investigations.
Corymbia calophylla – Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Endangered	**Unlikely.** Not expected to occur within the ERB based on findings in previous investigations.
Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain	Endangered	**Unlikely.** Not expected to occur within the ERB based on findings in previous investigations.
Shrublands and Woodlands of the eastern Swan Coastal Plain	Endangered	**Unlikely.** Not recorded or expected to occur within the ERB based on findings in previous investigations.
Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain	Endangered	**Unlikely.** Suitable habitat may be present in the Ellenbrook section. While it has the potential to occur, it is noted that the area has been surveyed and extensive clearing has already occurred in this area.
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	**Unlikely.** Not expected to occur within the ERB based on findings in previous investigations.

[1] Likelihood of occurrence criteria

Known: Recorded from the study area, through database search results and/or from previous surveys of the study area

Likely: The study area is within the known distribution and contains suitable habitat for the community, however; the adequate survey has not been undertaken to establish presence.

Potential: The study area is within the species distribution and contains suitable habitat, however survey limitations have been identified.

Unlikely: The study area is within the known distribution and either:

- Has been adequately surveyed and did not record the community; or
- No suitable habitat exists; or
- The habitat is modified and unlikely to support the community.

9.3.1.1 Banksia Woodlands of the Swan Coastal Plain ecological community

RPS (2019a) determined the presence and location of the Banksia Woodlands of the Swan Coastal Plain ecological community (Banksia Woodlands TEC) between Hepburn Avenue, Marshall Road and

Beechboro Road North within the Malaga and Whiteman Park South sections of the ERB and south of Gnangara Road in the Lord Street section. The comprehensive analysis of the occurrences of the Banksia Woodland TEC used multivariate analysis, floristics, soil, landform and geography, as well as key diagnostic criteria listed in the conservation advice documents for EPBC Act-listed TECs. RPS (2019a) confirmed all the Banksia woodland FCTs within the ERB in Good or better condition are EPBC Act-listed Banksia Woodlands TEC. Eight Banksia woodland vegetation units were assessed by RPS (2019a) as associated with Banksia Woodland TEC. More than 50 ha of Banksia Woodland vegetation of good or better condition within the ERB is representative of the EPBC Act-listed Banksia Woodlands TEC and would be protected under the EPBC Act as a MNES.

Outside of the RPS survey area, Coffey (2015c) also recorded occurrences of Banksia dominated PECs within the ERB at the Reid Highway and Tonkin Highway interchange, an area identified for clearing under the NorthLink project. Classification of the PECs was completed using multivariate statistical analysis, review of the desktop assessment and review of the vegetation recorded within the ERB. At the time of the Coffey (2015c) survey, the Banksia Woodlands TEC was not defined in conservation advice as a TEC. This EPBC Act-listed TEC represents a subset of numerous State-listed Banksia dominated PECs including those identified by Coffey. Only vegetation in Good or better condition may be considered representative of the Banksia Woodlands TEC. Actual locations of Banksia Woodland TEC were not defined by this survey.

9.3.1.2 Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain

Intact assemblages of this community are very rare across the Swan Coastal Plain. A key determinant of this community is hydrological features and soil characteristics. The permanently moist habitats associated with this community (and by extension the flora and fauna assemblages associated with the community) should be derived from continuous discharge of groundwater in raised areas of peat. This provides a constant and permanently damp series of microhabitats. The community has an overstorey of *Melaleuca preissiana, Banksia littoralis*, *Agonis linearifolia* and *Eucalyptus rudis*, with common understorey of *Agonis linearifolia, Pteridium esculentum* and *Cyclosorus interruptus* (CALM 2006). RPS (2018) lists several indicator species: *Aotus cordifolia* and *Taxandria linearifolia* were found at all three sites and *Cyathochaeta teretifolia* was found at two of the three sites. However, these species are also more often associated with wetlands and sumplands.

RPS (2019a) recorded species assemblages synonymous with this community at three sites within the wetlands of Whiteman Park (Lord street section). One record was within the ERB and two records were approximately 120 m west of the ERB. This TEC was not confirmed at the time but potentially represented up to three new occurrences. However, the DBCA has since advised that none of these occurrences meet the criteria for the TEC, primarily due to the absence of elevated areas of peat (English, pers. comm. 2018). The nearest known occurrence of this TEC is 1 km to the northeast of the ERB in Ellenbrook, with the northernmost part of the ERB intersecting the record's buffer (Figure 2-2). Given the fieldwork that has been completed in this area, there are unlikely to be further occurrences not yet recorded.

This TEC is also listed under the BC Act as the Critically Endangered TEC 'Communities of Tumulus Springs (Organic Mound Springs) of the Swan Coastal Plain TEC' (see Section 2.3.4.2).

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9.3.1.3 Clay pans of the Swan Coastal Plain

Based on current survey results and aerial imagery, it is not expected that floristic aspects of this community occur within the ERB or that intact representations of this landform occur. Historical investigations have not listed any confirmed occurrences within a 3 km buffer of the ERB.

9.3.1.4 Corymbia calophylla – Kingia australis woodlands on heavy soils of the Swan Coastal Pain

Based on previous investigations and aerial imagery, floristic aspects of this community are not expected to occur within the ERB. The key indicator species *Corymbia calophylla* and *Kingia australis* will occur, particularly as remnant individuals scattered across pastoral land. However, the presence of an intact assemblage sufficient to meet the definition of the community is not expected. Previous investigations have not listed any confirmed occurrences within a 3 km buffer of the ERB.

9.3.1.5 Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain

Based on previous investigations and aerial imagery, ELA does expect floristic aspects of this community occur within the ERB. This community is characterised by a dominant *Corymbia calophylla* (Marri) overstorey, with occasional *Eucalyptus wandoo*. Marri occurs in the ERB; however, in co-dominance with *Banksia* species and/or *Eucalyptus marginata* - more indicative of Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region, a different community. This Corymbia-Xanthorrhoea community was widespread and historically targeted for agricultural clearing. As such, remnant Marri trees will occur, but are not expected to form a contiguous community as defined by the TEC. Previous investigations have not listed any confirmed occurrences within a 3 km buffer of the ERB.

9.3.1.6 Shrublands and woodlands of the eastern Swan Coastal Plain

Based on previous investigations and aerial imagery, floristic aspects of this community occur within the ERB are not expected. This community occurs mainly on transitional soils of the Ridge Hill Shelf (adjacent to the Darling Scarp), which have not been identified within the ERB. A similar suite of species occurs within the ERB; however, landform and landscape position are not consistent with descriptions for this TEC. Previous investigations have not listed any confirmed occurrences within a 3 km buffer of the ERB.

9.3.1.7 Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain

Previous investigations have confirmed an occurrence within a 3 km buffer of the ERB (Ellenbrook section); however, this community occurs on very specific landform and soil types (limestone substratum associated with black clay soils of the eastern side of the SCP) (DotEE 2019f). The ERB is comprised of the following geological units (as defined by DMIRS 2018 for Perth): clayey silt, pebbly silt, sandy silt and sand. As such, it is possible that this community may occur within the ERB on the clayey silt areas. Within the ERB, clayey silt areas are mapped in the 1:50,000 geological dataset along Bennett Brook and some minor drainage lines connecting wetland chains through this area, principally to the north of the ERB in Whiteman Park (DMIRS 2018). However, field investigations did not record any instances of this community in these areas. A buffered record of this TEC exists in the Ellenbrook area, however this area is associated with cleared areas and residential dwellings and the area is therefore unlikely to support further occurrences.

9.3.1.8 Subtropical and Temperate Coastal Saltmarsh

Based on previous investigations and aerial imagery, floristic aspects of this community are not expected to occur within the ERB. In WA this community is linked to saline lakes and lagoons, previously or

currently connected to the ocean. Such landforms and associated saltmarsh vegetation do not occur within the ERB.

9.3.2 Threatened flora

No EPBC Act-listed flora species have been recorded within the ERB to date. RPS 2019a have undertaken targeted searches for the Grand Spider Orchid *Caladenia huegelii* within known habitat of remnant Banksia woodland. Two areas are outside the ERB adjacent to the Lord Street section, and two areas are within the ERB in the Malaga and Whiteman Park South section. The RPS (2019a) detailed flora and vegetation survey identified the potential for *Conospermum undulatum* and *Trithuria occidentalis* to occur within or surrounding the ERB, due to the proximity of known occurrences and/or the presence of suitable habitat.

9.3.2.1 Caladenia huegelii

Known from several locations within a 5 km radius of the ERB, targeted searches for *Caladenia huegelii* were conducted within areas determined to be suitable habitat for this species within the ERB (predominantly remnant Banksia woodland) (RPS 2019a). The survey identified that the year was considered an 'average year' to identify the species. While no individuals of this species were recorded at this time, current guidelines indicate that the lack of individuals is not necessarily indicative of true absence in the area in any given year.

C. huegelii occurs in mixed woodland of *Eucalyptus marginata, Banksia attenuata*, *B. ilicifolia* and *B. menziesii* with scattered *Allocasuarina fraseriana* and *Corymbia calophylla* over dense shrubs of *Stirlingia latifolia, Hypocalymma robustum*, *Hibbertia hypericoides*, *H. subvaginata, Xanthorrhoea preissii, Adenanthos cuneatus* and *Conostylis* species. Throughout its range, the species tends to favour areas of dense undergrowth and occurs on deep grey–white sand associated predominantly with the Bassendean sand dune system (RPS 2019a). Suitable habitat for this species is present within the Banksia woodlands of the ERB within the Lord Street, Whiteman Park South and Malaga sections.

9.3.2.2 Conospermum undulatum

The nearest DBCA database records for *Conospermum undulatum* are approximately 2 km southeast of the ERB in Redcliffe (RPS 2019a). It is known to occur on sand and sandy clay soils, often over laterite, on flat or gently sloping sites between the Swan and Canning Rivers (DotEE 2019b). It can also occur in association with Banksia and jarrah/marri woodland, including the SCP20a ecological community (DotEE 2019b).

The species was not recorded during the field survey (RPS 2019a). *C. undulatum* has the potential to be present given the presence of suitable habitat within the ERB (RPS 2019a). No other previous investigations have recorded this species within the surveyed extent of the ERB.

9.3.2.3 Trithuria occidentalis

This species was not recorded by Coffey (2015a) or RPS (2019a). This species prefers the edge of shallow, winter-wet claypans in very open shrubland of *Melaleuca lateritia* (DotEE 2019b, Coffey 2015a). It is considered to have the potential to occur within the ERB due to the presence of suitable habitat (RPS 2019a).

9.3.3 Threatened fauna

Based on the previous fauna surveys outlined in Section 3.3.2 and database searches (DotEE 2019a; DBCA 2007-2019, DBCA 2019b), a total of 10 Threatened or Migratory fauna MNES were either recorded or determined to be likely (or with potential) to occur within the ERB (Table 9-3). It should be noted that oceanic or pelagic species identified in the database searches have been excluded from this assessment given that they do not occur, nor does suitable habitat occur, within the ERB.

Three fauna species listed under the EPBC Act have previously been recorded within the ERB including (Table 9-3):

- Carnaby's Cockatoo;
- Forest Red-tailed Black Cockatoo; and
- Glossy Ibis.

A further five conservation significant fauna species listed under the EPBC Act are considered likely (or with potential) to occur within the ERB, given the proximity of nearby records and/or availability of suitable habitat including (Table 9-3):

- *Apus pacificus* (Fork-tailed Swift);
- *Ardea modesta* (Eastern Great Egret);
- *Calyptorhynchus baudinii* (Baudin's Cockatoo);
- *Botaurus poiciloptilus* (Australasian Bittern); and
- *Galaxiella nigrostriata* (Black-stripe minnow).

All of the species that have been recorded or are considered as likely (or with potential) to occur are described in further detail below. The remaining species were considered unlikely to occur given the lack of suitable habitat and/or lack of nearby records (Table 9-3).

Table 9-3: Likelihood of occurrence of terrestrial fauna MNES

Species	Conservation status		Distribution and habitat	Likelihood of occurrence within the ERB[3]
	EPBC Act[1]	BC Act[2]		
Birds				
Carnaby's Cockatoo (*Calyptorhynchus latirostris*)	EN	EN	Carnaby's Cockatoo is endemic to southwest WA with populations extending from the Murchison River to Esperance, and inland to Coorow, Kellerberrin and Lake Cronin (DotEE 2019b, DSEWPAC 2012). Carnaby's Cockatoo foraging habitat includes native shrubland, kwongan heathland and woodland dominated by proteaceous plant species including Banksia, Hakea and Grevillea, and pine plantations (DSEWPAC 2012, DPaW 2013).	**Recorded.** Carnaby's Cockatoo have been observed foraging in previous fauna surveys overlapping the ERB (Terrestrial Ecosystems 2018, Coffey 2015c, GHD 2014). 50% of individual fauna records provided from the DBCA database search were Carnaby's Cockatoo.
Baudin's Cockatoo (*Calyptorhynchus baudinii*)	EN	VU	Baudin's Cockatoo is found in southwest WA with populations extending from Albany northward to Gidgegannup and Mundaring (east of Perth), and inland to the Stirling Ranges and near Kojonup (DotEE 2019b, DSEWPAC 2012). Baudin's Cockatoo foraging habitat includes Eucalyptus woodlands and forest, and proteaceous woodland and heath (DSEWPAC 2012).	**Potential to occur – vagrant**. Baudin's Cockatoo may infrequently be seen foraging in the project area but would typically return to the hills to roost at night. They are highly unlikely to breed or roost in the MEL proposal ERB.
Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)	VU	VU	Forest Red-tailed Black Cockatoo is found in southwest WA with populations extending north to Perth and east to Wundowie, Mount Helena, Christmas Tree Well, North Bannister, Mount Saddleback, Rocky Gully and the upper King River (DSEWPAC 2012). Forest Red-tailed Black Cockatoo foraging habitat includes jarrah and marri woodlands and forests.	**Recorded.** Forest Red-tailed Black Cockatoo have been observed foraging in previous fauna surveys overlapping the ERB (Terrestrial Ecosystems 2018, AECOM 2016, Coffey 2015c, GHD 2014).
Australian Painted Snipe (*Rostratula benghalensis australis)*	EN	EN	The Australian Painted Snipe has been recorded at wetlands in all states of Australia, however it is most common in eastern Australia (DotEE 2019b). This species generally inhabits shallow terrestrial freshwater wetlands, including temporary and permanent lakes, swamps and claypans, sometimes utilising areas that are lined with trees, or that have some scattered fallen or washed-up timber (DotEE 2019b).	**Unlikely.** Australian Painted Snipe are most common in Eastern Australia and are rarely recorded in Western Australia.
Fork-tailed Swift (*Apus pacificus*)	Mi	–	The Fork-tailed Swift is a non-breeding visitor to all states and territories of Australia. In Western Australia there are widespread but scattered records of the Fork-tailed Swift along much of the coastline, with some sparsely scattered inland records, especially in the Wheatbelt (DotEE 2019b). They are almost exclusively aerial, and are most commonly found over inland plains, but sometimes above foothills or in coastal areas (DotEE 2019b).	**Likely.** Suitable habitat is present in the ERB.

Species	Conservation status		Distribution and habitat	Likelihood of occurrence within the ERB[3]
	EPBC Act[1]	BC Act[2]		
Glossy Ibis (*Plegadis falcinellus*)	Mi	Mi	The Glossy Ibis is widespread throughout the world, with the exception of southeast Asia, where it is scarce. In Australia it is generally located east of the Kimberley in Western Australia and the Eyre Peninsula in South Australia (DotEE 2019b).	**Recorded.** The Glossy Ibis was recorded at Horse Swamp (RPS in prep.).
Cattle Egret (*Ardea ibis*)	Mi	–	The Cattle Egret is native to Africa, southwest Europe and Asia. In Australia, it is widespread and common and in Western Australia, the Cattle Egret is most common in the north east from Wyndham through to Arnhem Land, in the NT. In the non-breeding season, it can occur in far south-west coastal areas of Western Australia.	**Unlikely.** The ERB is located outside of the predominant distribution in Western Australia.
Eastern Great Egret (*Ardea modesta*)	Mi	–	The Eastern Great Egrets occurs across Australia including in south-west Western Australia, where it utilises a wide range of wetland habitats.	**Likely.** Suitable habitats are available within wetland and dampland habitats within the ERB.
Australasian Bittern (*Botaurus poiciloptilus*)	EN	EN	This species occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats. It favours 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. The species favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea and Bolboschoenus) or cutting grass (Gahnia) growing over muddy or peaty substrate (DotEE 2019b).	**Potential.** The species has not been recorded during previous surveys; however, one database record exists approximately 11 km north west of the ERB. Given the occurrence of suitable habitat such as wetlands and dense vegetation this species may potentially occur.
Mammals				
Woylie (*Bettongia penicillata ogilbyi*)	EN	CR	Woylies prefer patches of dense undergrowth, that provide continuous canopy and therefore refuges against introduced predators. Scattered Woylie populations may be found throughout the jarrah forest in the south-west corner of Western Australia (DEC 2012c).	**Unlikely.** There are translocated populations of Woylies within fenced enclosures in Whiteman Park (AECOM 2016, DEC 2012c) but this species is considered unlikely to occur within the ERB outside this area.
Chuditch (*Dasyurus geoffroii*)	VU	VU	Chuditch currently only occurs in areas dominated by sclerophyll forest or drier woodland, heath and mallee shrubland and require adequate numbers of suitable den and refuge sites and sufficient prey biomass to survive (DEC 2012a). The majority of records are found in the contiguous Jarrah forests of the south west of Western Australia.	**Unlikely.** There are no known established populations within the Greater Perth metropolitan area.

Species	Conservation status		Distribution and habitat	Likelihood of occurrence within the ERB[3]
	EPBC Act[1]	BC Act[2]		
Fish				
Black-stripe minnow, (*Galaxiella nigrostriata*)	EN	EN	The Black-striped minnow is restricted to the ephemeral peat wetlands of south western Australia where it has a distribution ranging from Lake Chandala, north of Muchea, south to Augusta and along the south western coastline to the west of Albany (TSSC 2018). This species is believed to have once inhabited Bennett Brook and has more recently been recorded nearby in Ellen Brook (North Metro Catchment Group 2006).	**Potential.** This species has been recorded approximately 4.2 km east of the ERB in Henley Brook. The species is also believed to have previously occurred in the Bennett Brook although it was not recorded during the most recent aquatic fauna survey (North Metro Catchment Group 2006).

[1] Species listed under the EPBC Act
CR = listed as Critically Endangered under the EPBC Act.
EN = listed as Endangered under the EPBC Act.
VU = listed as Vulnerable under the EPBC Act.
[2] Species listed in Western Australia under the *Biodiversity Conservation Act 2016* (BC Act) or by the Department of Biodiversity, Conservation and Attractions (DBCA)
CR = Schedule 1: Fauna that is rare or is likely to become extinct as critically endangered flora (CR) under the BC Act.
EN = Schedule 2: Fauna that is rare or is likely to become extinct as endangered flora (EN) under the BC Act.
VU = Schedule 3: Fauna that is rare or is likely to become extinct as vulnerable flora (VU) under the BC Act.
Mi = Schedule 5: Migratory birds protected under an international agreement. A subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species under the BC Act.
P1 = Priority 1: Poorly-known species – species that are known from one or a few locations (generally five or less) which are potentially at risk (DBCA).
P2 = Priority 2: 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 (DBCA).
P3 = Priority 3: Poorly-known species – species that are known from several locations, and the species does not appear to be under imminent threat (DBCA).
P4 = Priority 4: Rare, Near Threatened and other species in need of monitoring (DBCA).
[3] Likelihood of occurrence criteria
Known to occur: Recorded from the study area, through database search results and/or from previous surveys of the study area (<20 years)
Likely to occur: The study area is within the species current distribution and contains suitable habitat for the species, however; the species utilises seasonal habitat or has a large home range, so is not always present/visible in the study area; and/or Survey limitations identified.
Potential to occur: The study area is within the species current distribution and contains habitat, however (at least two of below);

- The study area is located on the edge of the species range or it has a patchy distribution; and/or
- Survey limitations identified; and/or
- Habitat is less suitable; and/or
- Species is cryptic, and/or difficult to record utilising traditional survey methods.

Potential to occur – vagrant: Species has the potential to occur on a vagrant, or transient, basis only in that:

- May occasionally occur within the site;
- May occasionally fly or forage over the site (aerial species only);
- Are unlikely to utilise the site for foraging, breeding or nesting; and
- Are unlikely to utilise the site on an ongoing or permanent basis.

Unlikely to occur: The study area is within the species current distribution and either:

- Contains habitat, was adequately surveyed (including for seasonal, migratory and cryptic species and fauna species with large home ranges) and did not record the species; or
- The habitat is modified and unlikely to support the species and survey limitations identified.

9.3.3.1 Black cockatoos

Carnaby's Cockatoo and FRTBC have both been recorded foraging in and flying over the ERB (GHD 2014, Coffey 2015c, Terrestrial Ecosystems 2018 and AECOM 2016; (Figure 3-2). Baudin's Black Cockatoo is considered to potentially occur as a vagrant on a foraging only basis and possibly occurs in the ERB as an infrequent visitor.

Foraging habitat for black cockatoos has previously been recorded in a number of areas within or overlapping the ERB (Figure 3-2). Approximately 17.30 ha of suitable foraging habitat within the Tonkin Highway Section of the ERB (360 Environmental 2013a); however, no indirect evidence of foraging (i.e. chewed marri nuts or banksia cones) was observed. Some small areas of foraging habitat were identified around the Bayswater section of the ERB by GHD (2014). Foraging habitat has been recorded within the Malaga section of the ERB by Coffey (2015c). The majority of this habitat was assessed as being low quality; however, some small areas south of the Reid Highway, East of the Tonkin Highway and around Micro Gardens Park were assessed as being high quality foraging habitat given that they contain a mixture of suitable foraging, roosting and breeding habitat for black cockatoos.

AECOM (2016) mapped black cockatoo habitat across the Ellenbrook Rapid Bus Transit route along Lord Street and concluded these areas did not possess a high diversity or density of foraging species for black cockatoos. Areas of pine plantation intersecting the ERB at the northern end of the Lord Street Section were also mapped during this survey which provide an important food source for Carnaby's Cockatoo and potentially for Baudin's Cockatoo.

Foraging habitat was mapped in a number of small sections of the ERB by Terrestrial Ecosystems (2018). Approximately 64.5 ha of foraging habitat was rated as 1 (i.e. contained a few plants that would occasionally provide a food source for Black-Cockatoos), 81.1 ha rated as 2 (i.e. contained plants that are a preferred food source for Black-Cockatoos) and 7.7 ha rated as 3 (contained an abundance of plants that are a preferred food source for Black-Cockatoos). Areas with a foraging habitat rating of 2 or higher occurred in the Lord Street section of the ERB and in areas outside the ERB. A pine plantation was recorded just north of Drumpellier Drive; however, this area was outside the current ERB. This pine plantation provides suitable foraging habitat and potential roosting for black cockatoos (Terrestrial Ecosystems (2018).

Whilst the ERB lies outside the modelled breeding ranges of Carnaby's Cockatoo and FRTBC, both species have recently been recorded breeding within the Perth metropolitan area (Birdlife 2015). Carnaby's Cockatoos have been breeding at Joondalup Campus, approximately 17 km north west of the ERB and FRTBC have been recorded breeding at Murdoch University approximately 17 km south of the ERB.

A number of trees in the ERB are considered to represent potential breeding trees for both species due to the presence of suitable nest hollows or the tree having a DBH over 500 mm (DSEWPAC 2012; Figure 3-2). These trees occur predominantly within Eucalypt/Corymbia woodland and wetland habitats in the Tonkin Highway, Malaga, Lord Street and Ellenbrook sections of the ERB (Figure 3-2). A small number of potential breeding trees also occur in the Bayswater section of the ERB (Figure 3-2).

While no known roosting sites occur within the ERB, known roost sites occur nearby along Gnangara Road (approximately 800 m west of the ERB), within Whiteman Park (approximately 1.8 km west of the ERB) and within the Gnangara Pine Plantation (approximately 7.6 km west of the ERB) (Peck et al. 2017) (Figure 3-2). A potential roosting site is recorded by DBCA in Whiteman Park near Mussel Pool, within

the ERB. Baudin's and Carnaby's Cockatoo roosting habitat generally includes tall trees in proximity to riparian environments or nearby water sources, whereas FRTBC generally roost in any tall tree, particularly jarrah and marri, or any large trees on the edges of forests. Potential roosting habitat for all three black cockatoo species occurs within the Eucalypt/Corymbia woodland, Wetland, Dampland and Pine Plantation habitat types within (or in proximity to) the ERB (Terrestrial Ecosystems 2018; Coffey (2014; 2015c); PGV Environmental (2012b, 2014a). Potential roosting habitat was identified within the Bayswater, Malaga, and Lord Street sections of the ERB. Whilst potential roosting habitat was identified in a number of surveys, evidence of roosting such as scats or feathers were not recorded.

- The habitat values of the ERB in relation to black cockatoos can be summarised as follows: Carnaby's Cockatoo and FRTBC have both been recorded within the ERB.
- Baudin's Cockatoo has been recorded nearby in Whiteman Park and is therefore considered to have the potential to occur in the ERB. However, it is likely to only be an occasional visitor and would only utilise the ERB for foraging (and potentially roosting). Baudin's Cockatoo does not breed within the ERB.
- Foraging habitat for black cockatoos has been recorded in all sections of the ERB.
- The majority of foraging habitat was assessed as low quality; however, a number of moderate to high quality foraging areas exist within the Lord Street section of the ERB and some small areas south of the Reid Highway, East of the Tonkin Highway and around Micro Gardens Park (Coffey 2015c; Terrestrial Ecosystems 2018).
- A number of pine plantations occur within the ERB which provide suitable foraging and roosting habitat for Carnaby's Cockatoo and potentially for Baudin's Cockatoo.
- Potential breeding trees for Carnaby's Cockatoo and FRTBC include tall trees with a DBH over 500 mm and/or the presence of suitable hollows. Suitable breeding trees were recorded throughout the ERB in the Bayswater, Tonkin Highway, Malaga, Lord Street and Ellenbrook sections of the ERB.

9.3.3.2 Australasian Bittern (Botaurus poiciloptilus)

This species was identified in the PMST as possibly occurring within the ERB. This species occurs in terrestrial freshwater wetlands and, rarely, estuarine habitats. It favours 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. The species favours permanent and seasonal freshwater habitats, particularly those dominated by sedges, rushes and/or reeds (e.g. *Phragmites, Cyperus, Eleocharis, Juncus, Typha, Baumea* and *Bolboschoenus*) or cutting grass (*Gahnia*) growing over muddy or peaty substrate (DotEE 2019b). The species has not been recorded during previous surveys; however, one DBCA database record exists approximately 11 km north west of the ERB within Lake Jandabup. Given the availability of suitable wetland habitats, this species has the potential to occur within the ERB.

9.3.3.3 Black-stripe minnow (Galaxiella nigrostriata)

The Black-striped minnow is restricted to the ephemeral peat wetlands of south western Australia where it has a distribution ranging from Lake Chandala, north of Muchea, south to Augusta and along the south western coastline to the west of Albany (TSSC 2018). This species may have once inhabited Bennett Brook and has more recently been recorded nearby in Ellen Brook (North Metro Catchment Group 2006). Given the availability of suitable habitat and proximity of nearby records, the Black-striped

Minnow has potential to occur within the ERB, though ELA notes that reasonably extensive sampling in 1997-98 and 2006 did not record the species (North Metro Catchment Group 2006).

9.3.4 Migratory species

RPS conducted a waterbirds survey on 15, 25 and 26 November 2018 at several locations including Horse Swamp, Bennett Brook, Mussel Pool, seasonal wetlands and dams in the Whiteman Park South section (RPS in prep.). From a preliminary species list provided to ELA, one listed migratory species, the Glossy Ibis (*Plegadis falcinellus*), was recorded at Horse Swamp (RPS in prep.; Table 9-3). This species has a regional distribution across the east of the Kimberley in Western Australia and is also known to be patchily distributed in the rest of Western Australia (DotEE 2019b). Its preferred habitats for foraging and breeding are fresh water marshes at the edges of lakes and rivers, lagoons, flood-plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation (DotEE 2019b). This species is also occasionally found in coastal locations such as estuaries, deltas, saltmarshes and coastal lagoons (DotEE 2019b). The Ord River is a known breeding area for this species in Western Australia, with core breeding areas located outside of Western Australia (DotEE 2019b).

A further three Migratory species were identified as possibly occurring from database searches (DotEE 2019a; DBCA 2007-2019, DBCA 2019b) (Table 9-3). Of these, two were considered likely (or with potential) to occur within the ERB including the Fork-tailed Swift and Eastern Great Egret based on suitable habitat. The Cattle Egret was considered unlikely to occur given the lack of nearby records and/or suitable habitats (Table 9-3).

The draft Perth and Peel Green Growth Plan for 3.5 million (DPC 2015) documents include consideration of important habitat for migratory shorebirds across the Perth and Peel region. Strategic Assessment draft documents identify 18 wetlands sites across the region supporting important habitat for migratory shorebirds (DPC 2015). No migratory wetland species habitat areas relevant to the ERB were identified in the draft Perth and Peel Green Growth Plan for 3.5 million (DPC 2015).

9.4 Potential constraints

Analysis of information currently available relating to the MEL project has identified the following as potential constraints:

- One listed TEC:
  - Banksia Woodlands of the SCP ecological community – confirmed.
- Seven listed Threatened fauna species:
  - Carnaby's Cockatoo – recorded;
  - Forest Red-tailed Black Cockatoo – recorded;
  - Baudin's Cockatoo – potential (vagrant);
  - Australasian Bittern – potential; and
  - Black-stripe minnow – potential.
- One listed Threatened flora species:
  - Grand Spider Orchid (*Caladenia huegelii*) – potential.

- Three listed migratory species:
  - Glossy Ibis – recorded;
  - Fork-tailed Swift – likely; and
  - Eastern Great Egret – likely.

The Banksia Woodlands of the SCP TEC has been confirmed as present in the Malaga and Whiteman Park South sections, between Hepburn Avenue, Marshall Road and Beechboro Road North, and to the south of Gnangara Road in the Lord Street section, as well as several other locations in the surrounding area. The DBCA database search shows locations of the TEC along Beechboro Road North and northeast of Ellenbrook.

Seven listed Threatened fauna species were recorded or considered likely to occur within various locations of the ERB. The ERB contains black cockatoo foraging and roosting habitat for all three black cockatoo species, and potential breeding habitat for Carnaby's Cockatoo and FRTBC.

The Glossy Ibis, a listed migratory species, has been recorded in Horse Swamp. A further two migratory species are considered likely to occur: Fork-tailed Swift and Eastern Great Egret.

Caladenia huegelii was also known from several locations within a 5 km radius of the ERB, despite targeted searches not recording this species in suitable habitat. While no individuals of this species were recorded at this time, current guidelines indicate that the lack of individuals is not necessarily indicative of true absence in the area in any given year.

As described in Sections 2.5 and 3.5, further work is likely to be required to ensure sufficient information regarding MNES is available during future assessment processes.

10. References

360 Environmental. 2013a. Black-Cockatoo Assessment - Tonkin Highway. Prepared for Main Roads Western Australia, Perth.

360 Environmental. 2013b. Tonkin Highway Expansion between Reid Highway and Guildford Road - Preliminary Environmental Impact Assessment. Prepared for Mains Road Western Australia, Perth.

360 Environmental. 2014a. Flora, Vegetation and Fauna Survey: Tonkin Grade Separations. Prepared for Main Roads Western Australia, Perth.

360 Environmental. 2014b. Tonkin Grade Separation Project - Preliminary Site Investigation on Contamination. Prepared for Main Roads Western Australia, Perth.

AECOM. 2016. Ellenbrook Bus Rapid Transit Biological Assessment. Prepared for Department of Transport, Western Australia.

Amergin Consulting. 2015. Report of an Ethnographic Aboriginal Heritage Survey of the Proposed NorthLink WA Project, Part 2: Perth-Darwin National Highway. Unpublished report prepared for Main Roads Western Australia, Perth.

Aurecon. 2016. Ellenbrook Bus Rapid Transit Environmental Impact Assessment and Environmental Management Plan. Unpublished report prepared for Main Roads Western Australia, Perth.

Australian Soil Resource Information System (ASRIS). 2014. Soil Database. Accessed 21 February 2019 http://www.asris.csiro.au/

Bamford Consulting Ecologists. 2011. Roads and Wildlife. A Review of Purpose-Built Fauna Underpasses.

Beard, J. S. 1979. Vegetation Survey of WA: The Vegetation of the Perth Area WA, map and explanatory memoir. 1:250,000 series, Vegmap Publications, Applecross.

Beard, J. S. 1990. Plant Life of Western Australia, Kangaroo Press Pty Ltd, Kenthurst NSW.

Bennelongia Environmental Consultants (Bennelongia). 2016. Groundwater Replenishment Scheme Stage 2: Subterranean Fauna Desktop Assessment. Prepared for the Water Corporation.

Birdlife. 2015. Cocky Notes. Issue 22: Summer 2015.

Brad Goode & Associates. 2015. Due Diligence Risk Assessment for the Proposed Lord Street Busway, from Bennett Springs to Ellenbrook, Western Australia. Unpublished report prepared for Main Roads Western Australia, Perth.

Brad Goode & Associates. 2016. Addendum: Report on Aboriginal Heritage Survey for Site ID 551 Lord Street North 1, Whiteman Park, Western Australia. Unpublished report prepared for Main Roads Western Australia, Perth.

Bush, B., Maryan, B., Browne-Cooper, R. and Robinson, D. 2010. Field Guide to Reptiles and Frogs of the Perth Region. University of Western Australia Press.

CALM. 2006. Community of Tumulus (Organic Mound Springs) of the Swan Coastal Plain Interim Recovery Plan No. 198. Department of Conservation and Land Management, Perth, Western Australia.

Coffey. 2014. Memorandum: Tonkin Grade Separations – Flora, Vegetation and Fauna Habitat Mapping Gaps Analysis. Prepared for Main Roads Western Australia, Perth.

Coffey. 2015a. Level 2 Flora and Vegetation Assessment: Perth-Darwin National Highway. Prepared for Main Roads Western Australia, Perth.

Coffey. 2015b. Public Environmental Review Perth-Darwin National Highway (Swan Valley Section) September 2015, Volume 1: Main text, Main Roads Western Australia, Perth.

Coffey. 2015c. NorthLink WA Level 2 Targeted Fauna Assessment Perth-Darwin National Highway. Prepared for Main Roads Western Australia, Perth.

Coffey. 2015d. Wetland Assessment Perth-Darwin National Highway, Main Roads Western Australia, Perth.

Coffey. 2015e. Preliminary Site Investigation - Perth-Darwin National Highway, NorthLink. Prepared for Main Roads Western Australia, Perth.

Coffey. 2015f. Preliminary ASS Investigation: Perth-Darwin National Highway, NorthLink. Prepared for Main Roads Western Australia, Perth.

Coffey. 2016. Final Public Environment Report: Part B Response to Submissions: Perth–Darwin National Highway (Swan Valley Section). February. Prepared for Main Roads Western Australia, Perth.

Commonwealth of Australia. 2013. Survey guidelines for Australia's Threatened Orchids: Guidelines for detecting orchids listed as 'Threatened' under the Environment Protection and Biodiversity Conservation Act 1999. Commonwealth of Australia.

Commonwealth of Australia. 2016. Banksia Woodlands of the Swan Coastal Plain: A Nationally Protected Ecological Community. Commonwealth of Australia.

Cook, M. 2011. Horse Swamp Environmental Management Plan, unpublished report prepared for Whiteman Park, Western Australia.

Cossill & Webley Consulting Engineers (Cossil & Webley). 2015. West Ellenbrook Engineering Servicing Report, September 2016.

Davidson. 1995. Hydrogeology and groundwater resources of the Perth region, Western Australia: Western Australia Geological Survey, Bulletin no. 142. Perth, Western Australia.

Department of Biodiversity, Conservation and Attractions (DBCA) 2007-2019. NatureMap: Mapping WA's Biodiversity. [Online] Available at: https://naturemap.dpaw.wa.gov.au/

Department of Biodiversity, Conservation and Attractions (DBCA). 2019a. Threatened ecological communities. Accessed on 22 March 2019 at https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/wa-s-threatened-ecological-communities.

Department of Biodiversity, Conservation and Attractions (DBCA). 2019b. Threatened and Priority Fauna Database Search. Received on 21 February 2019.

Department of Environment and Conservation (DEC). 2012a. Chuditch (Dasyurus geoffroii) Recovery Plan. Wildlife Management Program No. 54. Department of Environment and Conservation, Perth, Western Australia.

Department of Environment and Conservation (DEC). 2010. Definitions, Categories and Criteria for Threatened and Priority Ecological Communities. December 2010.

Department of Environment and Conservation (DEC). 2011. A Guideline for Managing the Impacts of Dust and Associated Contaminants from Land Development Sites, Contaminated Site Remediation and other Related Activities 2011 Department of Environment and Conservation, Perth, Western Australia.

Department of Environment and Conservation (DEC). 2012a. Chuditch (*Dasyurus geoffroii*) Recovery Plan. Wildlife Management Program No. 54. Department of Environment and Conservation, Perth, Western Australia.

Department of Environment and Conservation (DEC). 2012b. Bandicoots in the City. Media Release, World Wildlife Fund for Nature. Perth, Western Australia.

Department of Environment and Conservation (DEC). 2012c. National Recovery Plan for the Woylie (*Bettongia penicillata ogilbyi*). Wildlife Management Program No. 51. Department of Environment and Conservation, Perth, Western Australia.

Department of Environment and Conservation (DEC). 2012d. A guide to managing and restoring wetlands in Western Australia. Department of Environment and Conservation, Perth, Western Australia.

Department of Mines, Industry Regulation and Safety. 2018. Geological Survey of Western Australia, geoheritage. Accessed on 21 December 2018. Available at <http://www.dmp.wa.gov.au/Geological-Survey/Geoheritage-1412.aspx>

Department of Parks and Wildlife (DPaW). 2013. Carnaby's Cockatoo (*Calyptorhynchus latirostris*) Recovery Plan. Western Australian Wildlife Management Program No. 52. Department of Parks and Wildlife, Perth, Western Australia.

Department of Parks and Wildlife (DPaW). 2018. Wetland mapping: what do the wetland management categories mean? [Online] Available at: www.dpaw.wa.gov.au/management/wetlands/mapping-and-monitoring?showall=1 Accessed 18 February 2018.

Department of Premier and Cabinet (DPC). 2015. Draft Perth and Peel Green Growth Plan for 3.5 million. https://www.dpc.wa.gov.au/Consultation/StrategicAssessment/Pages/Draft-Green-Growth-Plandocuments.aspx. Department of Premier and Cabinet, West Perth, Western Australia.

Department of Primary Industries and Regional Development (DPIRD). 2018. Soil Landscape Mapping (DPRID-027). Accessed from: from https://nationalmap.gov.au/.

Department of Sustainability, Environment, Water, Population and Communities (DSEWPAC). 2012. EPBC Act referral guidelines for three threatened black cockatoo species. Commonwealth of Australia.

Department of the Environment (DoE). 2013. Matters of National Environmental Significance. Significant impact guideines 1.1. Environment Protection and Biodiversity Conservation Act 1999. Accessed on 9 January 2019 at http://www.environment.gov.au/epbc/publications/significant-impact-guidelines-11-matters-national-environmental-significance. Department of the Environment, Canberra. ACT.

Department of the Environment and Energy (DotEE). 2017. Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo, Baudin's Cockatoo and the Forest Red-tailed Black Cockatoo. Commonwealth of Australia.

Department of the Environment and Energy (DotEE). 2018. Species Profile and Threats Database. [Online] Available at: http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

Department of the Environment and Energy (DotEE). 2018. EPBC Act Protected Matters Search Tool, [Online] Available at: http://www.environment.gov.au/epbc/pmst/index.html.

Department of the Environment and Energy (DotEE). 2019a. Species Profile and Threats Database. [Online] Available at: www.environment.gov.au/cgi-gin/sprat/public/sprat.pl

Department of the Environment and Energy (DotEE). 2019b. Species Profile and Threats Database: *Calyptorhynchus baudinii* - Baudin's Cockatoo. [Online] Available at: www.environment.gov.au/cgi-gin/sprat/public/publicspecies.pl?taxon_id=769

Department of the Environment and Energy (DotEE). 2019c. Species Profile and Threats Database: *Calyptorhynchus banksii naso* - Forest Red-tailed Black Cockatoo. [Online] Available at: www.environment.gov.au/cgi-gin/sprat/public/publicspecies.pl?taxon_id=67034

Department of the Environment and Energy (DotEE). 2019d. Species Profile and Threats Database: *Calyptorhynchus latirostris* - Carnaby's Cockatoo. [Online] Available at: www.environment.gov.au/cgi-gin/sprat/publkic/publkicspecies.pl?taxon_id=59523

Department of the Environment and Energy (DotEE). 2019e. Species Profile and Threats Database: Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain. [Online] Available at: http://www.environment.gov.au/cgi-bin/sprat/public/publicshowcommunity.pl?id=21&status=Endangered

Department of Water (DoW) and Department of Parks and Wildlife (DPaW). 2015. Swan Canning Nutrient Update 2015, Department of Water, Perth.

Department of Water and Environmental Regulation (DWER). 2014. Assessment and management of contaminated sites: Contaminated sites guidelines. DER, Western Australia. Published December 2014.

Department of Water and Environmental Regulation (DWER). 2015. Identification and investigation of acid sulfate soils and acidic landscapes. DER, Western Australia. Published June 2015.

Department of Water and Environmental Regulation (DWER). 2018. Perth Groundwater Map – Online Resource. Accessed from www.water.wa.gov.au on 12 November 2018.

Department of Water and Environmental Regulation (DWER). 2019. Contaminated Sites Database. Accessed 21 February

2019. https://dow.maps.arcgis.com/apps/webappviewer/index.html?id=c2ecb74291ae4da2ac32c441819c6d47

Department of Water and Environmental Regulation and the Water Corporation (DWER and WC). 2017. METRONET water considerations. July.

English, V. 2018. Potential Communities of Tumulus Springs - METRONET Morley Ellenbrook Line. Email from Val English, Department of Biodiversity, Conservation and Attractions to Brenton Laslett, METRONET. 4 December 2018

Environment Australia. 2001. National Objectives and Targets for Biodiversity Conservation 2001-2005. Report prepared for Department of Environment and Heritage. Canberra, Australian Capital Territory.

Environment Protection Authority. 2013. Rail Infrastructure Noise Guideline. Environment Protection Authority, Sydney, NSW.

Environmental Protection Authority (EPA). 2004. Guidance Statement No. 51: Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment in Western Australia. EPA, Western Australia.

Environmental Protection Authority (EPA). 2012. A review of subterranean fauna assessment in Western Australia. EPA, Perth, Western Australia.

Environmental Protection Authority (EPA). 2015. Perth and Peel @ 3.5 million: Environmental impacts, risks and remedies. Interim strategic advice of the Environmental Protection Authority to the Minister for Environment under section 16(e) of the Environmental Protection Act 1986. July. EPA, Perth, Western Australia.

Environmental Protection Authority (EPA). 2016a. Environmental Factor Guideline: Flora and Vegetation. EPA, Perth, Western Australia. Published December 2016.

Environmental Protection Authority (EPA). 2016b. Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment. EPA, Perth, Western Australia. Published December 2016

Environmental Protection Authority (EPA). 2016c. Environmental Factor Guideline: Terrestrial Fauna, EPA. Perth, Western Australia. Published December 2016.

Environmental Protection Authority (EPA). 2016d. Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna. EPA, Perth, Western Australia. Published December 2016.

Environmental Protection Authority (EPA). 2016e. Technical Guidance: Terrestrial Fauna Surveys. EPA, Perth, Western Australia. Published December 2016.

Environmental Protection Authority (EPA). 2016f. Technical Guidance: Sampling of Short Range Endemic Invertebrate Fauna. EPA, Perth, Western Australia. Published December 2016.

Environmental Protection Authority (EPA). 2016g. Environmental Factor Guideline: Terrestrial Environmental Quality, EPA, Western Australia. Published December 2016

Environmental Protection Authority (EPA). 2016h. Environmental Factor Guideline: Social Surroundings, EPA, Perth, Western Australia. Published December 2016.

Environmental Protection Authority (EPA). 2016i. Environmental Factor Guideline: Subterranean Fauna. EPA, Perth, Western Australia. Published December 2016.

Environmental Protection Authority (EPA). 2016j. Technical Guidance: Subterranean Fauna Survey. EPA, Perth, Western Australia. Published December 2016.

Environmental Protection Authority (EPA). 2016k. Technical Guidance: Sampling Methods for Subterranean Fauna. EPA, Perth, Western Australia. Published December 2016.

Environmental Protection Authority (EPA). 2018a. Statement of Environmental Principles, Factors and Objectives. EPA, Perth, Western Australia. Published June 2018.

Environmental Protection Authority (EPA). 2018b. Environmental Factor Guideline: Inland Waters. EPA, Perth, Western Australia.

Environmental Protection Authority (EPA). 2018c. Environmental Factor Guideline: Landforms, EPA, Perth, Western Australia. Published June 2018.

Estill & Associates. 2005. Study of Groundwater-Related Aboriginal Cultural Values on the Gnangara Mound, Western Australia. Report prepared for the Department of Environment. Perth, Western Australia.

Ethnosciences. 2017. Report on a Desktop Aboriginal Heritage Assessment of Whiteman Park South Project Area. Unpublished report prepared for the Western Australian Planning Commission, Perth.

GHD. 2014. Public Transport Authority Forrestfield Airport Link Environmental investigation. Prepared for Public Transport Authority, Western Australia.

Golder Associates (Golder). 2015. Preliminary Site Investigation: Former Liquid Waste Facility, Lexia. P Government of Western Australia. 1997. Wetlands Conservation Policy for Western Australia. Prepared for Landcorp.

Government of Western Australia. 1997. Wetlands Conservation Policy for Western Australia. Prepared by the Department of Conservation and Land Management and Waters and Rivers Commission. Perth, Western Australia.

Government of Western Australia. 2000a. Bush Forever Volume 1: Policies, Principles and Processes. Perth, Western Australia.

Government of Western Australia. 2000b. Bush Forever Volume 2: Directory of Bush Forever Sites. Perth, Western Australia.

Government of Western Australia. 2010. State Planning Policy 2.8 - Bushland policy for the Perth Metropolitan Region. Prepared by the Western Australian Planning Commission, Perth, Western Australia.

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Government of Western Australia. 2011. Local Water Quality Improvement Plan: Bennett Brook Catchment.

Government of Western Australia. 2018. 2017 South West Vegetation Complex Statistics. Accessed 21/02/2019. https://catalogue.data.wa.gov.au/dataset/dbca/resource/b35f1bc0-bc44-471c-bb3a-d4db3805e441

Gozzard, J. R. 2007. Geology and landforms of the Perth Region. Western Australia Geological Survey, Perth, Western Australia.

Heddle, E.M., Loneragan, O.W. and Havel J.J. 1980. Vegetation Complexes of the Darling System, WA, in Atlas of Natural Resources, Darling System WA, Department of Conservation and Environment.

Invertebrate Solutions. 2018. Desktop Review and Risk Assessment of Subterranean Fauna for the Yanchep Rail Extension, Western Australia. Prepared for Public Transport Authority. Report No. 20181SJ02_F01_20180531, 31 May 2018.

Jacobs Australia Pty Ltd 2018. Morley to Ellenbrook Route protection study, MEL Option 2 Environment and Heritage Assessment, unpublished report prepared for Public Transport Authority, Perth, Western Australia.

Keighery, B. J., Keighery, G. J., Longman, V. M., and Clarke, K. A. 2012. Native and Weed Flora of the Southern Swan Coastal Plain: 2015 Dataset. Department of Environment and Conservation, Kensington, Western Australia.

Lloyd George Acoustics. 2016. Transportation Noise Assessment, NorthLink WA-Southern Section, Guildford Road to Reid Highway, 100% Design Submission Report. Unpublished report prepared for John Holland, Perth, Western Australia.

MRWA. 2015. Position paper NorthLink WA - Hydrogeological PER considerations - Groundwater level impact from construction, dewatering and groundwater abstraction.

North Metro Catchment Group. 2006. Freshwater Fish Survey of Bennett Brook.

Pacific Environment Limited. 2015. NorthLink WA: Air Quality Assessment. Unpublished report prepared for Coffey, Perth, Western Australia.

Peck et al. 2017. The 2017 Great Cocky Count. Birdlife Western Australia. Floreat WA.

PGV Environmental. 2014a. Lot 800 Youle-Dean Road, Brabham – Black Cockatoo Habitat Assessment. Prepared for Department of Housing, Western Australia.

PGV Environmental. 2014b. Brabham LSP 3 Area – Black Cockatoo Habitat Assessment. Prepared for Department of Housing, Western Australia.

PGV Environmental. 2014c.Lot 800 Youle-Dean Road, Brabham – Kangaroo Population and Management. Prepared for Department of Housing, Western Australia.

R. & E. O'Connor Pty Ltd. 2018. Desk-top Aboriginal Heritage Analysis of Proposed Morley to Ellenbrook Railway Line. Unprepared report prepared for Public Transport Authority, Perth, western Australia.

Richardson, S., Irvine, E., Froend, R., Boon, P. and Barber, S. 2011. Australian groundwater-dependent ecosystems toolbox part 1: Assessment framework. Waterlines report. December. Prepared for National water Commission. Canberra, Australian Capital Territory.

RPS in prep. Interim species list from waterbirds survey on 15, 25 and 26 November 2018. Provided by Public Transport Authority on 22 February 2019.

RPS. 2017. Bennett Springs East Structure Plan. Prepared for Western Australian Planning Commission.

RPS. 2018. Detailed Flora and Vegetation Assessment: METRONET Ellenbrook Alignment. Prepared for Public Transport Authority, Western Australia.

RPS. 2019a. Morley-Ellenbrook Line: Targeted Caladenia huegelii search 2018. Prepared for Public Transport Authority, Western Australia.

RPS. 2019b. Detailed Flora and Vegetation Assessment. METRONET Morley-Ellenbrook line. January. Draft. Prepared for Public Transport Authority, Western Australia.

Shepherd, D.P., Beeston, G.R., and Hopkins, A.J.M. 2002, Native Vegetation in WA - Extent, Type and Status, Resource Management Technical Report 249. Department of Agriculture, Western Australia.

SLR. 2015. Forrestfield-Airport Link Noise and Vibration Management, Construction and Operation Environmental Impact Report. Unpublished report prepared for Public Transport Authority. Perth, Western Australia.

Snappy Gum Heritage Services. 2015. A Report on the Archaeological Assessment of the NorthLink WA project (Perth-Darwin National Highway). Unpublished report prepared for Main Roads Western Australia, Perth.

South East Regional Centre for Urban Landcare (SERCUL). 2013. Bennett Brook catchment - water and sediment quality monitoring and evaluation: Ten-year Analysis 2002-2011, unpublished report prepared for the Swan River Trust.

Standards Australia. 2018. Mechanical vibration and shock - Evaluation of human exposure to whole body vibration (2631.5:2018). Standards Australia, NSW, Australia

Success Hill Action Group Inc. 1999. Bennett Brook baseline study of flora and fauna. A national land care community project funded under the One Billion Trees and Save the Bush programs 1994-95.

Terratree. 2014. Phytophthora dieback Linear Assessment. Perth-Darwin National Highway project Corridor. Report prepared for Coffey Western Australia.

Terratree. 2017. Level 2 Flora and Vegetation Assessment of Hepburn, Beechborough, and Marshall Road Sites. Prepared for Laing O'Rourke on behalf of Great Northern Connect, Western Australia.

Terrestrial Ecosystems. 2018. Level 1 Fauna Risk Assessment and Black-Cockatoo Habitat Assessment for the alternative Ellenbrook Rail Line Alignments of Metronet. Prepared for RPS Australia Asia Pacific.

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Threatened Species Scientific Committee (TSSC). 2016. Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community. Canberra, Department of the Environment and Energy.

Threatened Specis Scientific Committee (TSSC). 2018. Conservation advice: *Galaxiella nigrostrata* black-stripe minnow. February 2018.

Urban Bushland Council WA. 2019. Bush Forever [Online] Available at: https://www.bushlandperth.org.au/.

Water and Rivers Commission. 1999. Foreshore Assessment in the Bennett Brook Catchment. Water and Rivers Commission, Water Resource Management Series, No WRM 14.

Waters and Rivers Commission. 2000. Environmental Water Provisions Policy for Western Australia. Water and Rivers Commission, Statewide Policy No. 5.

Webb, A., Kinloch, J., Keighery, G. and Pitt, G. 2016. The extension of vegetation complex mapping to landform boundaries within the Swan Coastal Plain landform and forested region of south-west Western Australia. September. [Online] Available at: https://library.dbca.wa.gov.au/static/FullTextFiles/072149/072149.e.pdf. Accessed on 17 January 2019

Western Australia Planning Commission (WAPC). 2003. Statement of Planning Policy No. 2 - Environment and Natural Resources Policy. Western Australia Planning Commission, Perth, Western Australia.

Western Australian Local Government Association (WALGA). 2004. Local Government Biodiversity Planning Guidelines for the Perth Metropolitan Region. Western Australian Local Government Association and Perth Biodiversity Project, West Perth, WA.

Western Australian Planning Commission (WACP). 2007. Visual Landscape Planning in Western Australia, a manual for evaluation, assessment, siting and design. Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WACP). 2009. State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning. Department of Planning, Lands and Heritage, Western Australia.

Whiteman Park. 2012. Bennett Brook South Management Plan.

Whiteman Park. 2018. Whiteman Park Conservation and Environmental Management Plan

Whiteman Park. 2019. Whiteman Park. Sponsored by DPLH and WAPC. [Online] Available at: https://www.whitemanpark.com.au Accessed 20/02/2019.

Appendix A : Desktop fauna search

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Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

THREATENED AND PRIORITY FAUNA INFORMATION CONDITIONS OF SUPPLY

Conditions with Respect to the Supply of Information

- The data supplied may not be provided to any other organisations, nor be used for any purpose other than for the project for which it has been originally provided for; without the prior consent of the Executive Director, Department of Biodiversity, Conservation and Attractions.
- Specific locality information for threatened fauna is regarded as confidential, and should be treated as such by receiving organisations. Specific locality information for threatened fauna may not be used in reports without the written permission of the Executive Director, Department of Biodiversity, Conservation and Attractions. Reports may only show generalised locations at a low resolution or, where necessary, show specific locations without identifying species. Species and Communities is to be contacted for guidance on the presentation of threatened fauna information.
- The Department of Biodiversity, Conservation and Attractions respects the privacy of private landowners who may have threatened and priority fauna on their property. Threatened and priority fauna locations identified in the data as being on private property should be treated in confidence, and contact with property owners must only be made through the Department of Biodiversity, Conservation and Attractions.
- Acknowledgment of the Department of Biodiversity, Conservation and Attractions as the source of data is to be made in any published material and cited as Department of Biodiversity, Conservation and Attractions (2019) Threatened and Priority Fauna Database Search for [search area] accessed on the [date of search]. Prepared by the Species and Communities Program for [Requesters name and company] for [purpose of search].
- Copies of all such publications are to be forwarded to the Department of Biodiversity, Conservation and Attractions, Attention; Principal Zoologist, Species and Communities.

Disclaimers with Respect to the Supply of Information

- Receiving organisations should note that while every effort has been made to prevent errors and omissions in the data, they may be present. The Department of Biodiversity, Conservation and Attractions accepts no responsibility for this.
- Receiving organisations must also recognise that the database is subject to continual updating and amendment, and such considerations should be taken into account by the user.
- It should be noted that the supplied data does not necessarily represent a comprehensive listing of the threatened fauna of the area in question. Its comprehensiveness is dependent on the amount of surveys carried out within a specified area. The receiving organisation should consider engaging a biologist/zoologist, if required, to undertake a survey of the area under consideration.

Note:

The Conservation Codes for Western Australian flora and fauna have been updated (3 January 2019).

Species and Communities, Biodiversity and Conservation Science
17 Dick Perry Avenue, Technology Park, Kensington
Email: fauna.data@dbca.wa.gov.au Phone: (08) 9219 9511
Postal Address: Locked Bag 104, Bentley Delivery Centre, WA 6983
www.dbca.wa.gov.au

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

CONSERVATION CODES

For Western Australian Flora and Fauna

Threatened, Extinct and Specially Protected fauna or flora[1] are species[2] which have been adequately searched for and are deemed to be, in the wild, threatened, extinct or in need of special protection, and have been gazetted as such.

The *Wildlife Conservation (Specially Protected Fauna) Notice 2018* and the *Wildlife Conservation (Rare Flora) Notice 2018* have been transitioned under regulations 170, 171 and 172 of the *Biodiversity Conservation Regulations 2018* to be the lists of Threatened, Extinct and Specially Protected species under Part 2 of the *Biodiversity Conservation Act 2016.*

Categories of Threatened, Extinct and Specially Protected fauna and flora are:

T **Threatened species**

Listed by order of the Minister as Threatened in the category of critically endangered, endangered or vulnerable under section 19(1), or is a rediscovered species to be regarded as threatened species under section 26(2) of the *Biodiversity Conservation Act 2016* (BC Act).

Threatened fauna is that subset of 'Specially Protected Fauna' listed under schedules 1 to 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for Threatened Fauna.

Threatened flora is that subset of 'Rare Flora' listed under schedules 1 to 3 of the *Wildlife Conservation (Rare Flora) Notice 2018* for Threatened Flora.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR **Critically endangered species**

Threatened species considered to be "*facing an extremely high risk of extinction in the wild in the immediate future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as critically endangered under section 19(1)(a) of the BC Act in accordance with the criteria set out in section 20 and the ministerial guidelines. Published under schedule 1 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for critically endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for critically endangered flora.

EN **Endangered species**

Threatened species considered to be "*facing a very high risk of extinction in the wild in the near future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as endangered under section 19(1)(b) of the BC Act in accordance with the criteria set out in section 21 and the ministerial guidelines. Published under schedule 2 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for endangered fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for endangered flora.

VU **Vulnerable species**

Threatened species considered to be "*facing a high risk of extinction in the wild in the medium-term future, as determined in accordance with criteria set out in the ministerial guidelines*".

Listed as vulnerable under section 19(1)(c) of the BC Act in accordance with the criteria set out in section 22 and the ministerial guidelines. Published under schedule 3 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for vulnerable fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for vulnerable flora.

Extinct species

Listed by order of the Minister as extinct under section 23(1) of the BC Act as extinct or extinct in the wild.

EX Extinct species

Species where "*there is no reasonable doubt that the last member of the species has died*", and listing is otherwise in accordance with the ministerial guidelines (section 24 of the BC Act).

Published as presumed extinct under schedule 4 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018* for extinct fauna or the *Wildlife Conservation (Rare Flora) Notice 2018* for extinct flora.

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*", and listing is otherwise in accordance with the ministerial guidelines (section 25 of the BC Act).

Currently there are no threatened fauna or threatened flora species listed as extinct in the wild. If listing of a species as extinct in the wild occurs, then a schedule will be added to the applicable notice.

Specially protected species

Listed by order of the Minister as specially protected under section 13(1) of the BC Act. Meeting one or more of the following categories: species of special conservation interest; migratory species; cetaceans; species subject to international agreement; or species otherwise in need of special protection.

Species that are listed as threatened species (critically endangered, endangered or vulnerable) or extinct species under the BC Act cannot also be listed as Specially Protected species.

MI Migratory species

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; and listing is otherwise in accordance with the ministerial guidelines (section 15 of the BC Act).

Includes birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and fauna subject to the *Convention on the Conservation of Migratory Species of Wild Animals* (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals, that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.

Published as migratory birds protected under an international agreement under schedule 5 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

CD Species of special conservation interest (conservation dependent fauna)

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened, and listing is otherwise in accordance with the ministerial guidelines (section 14 of the BC Act).

Published as conservation dependent fauna under schedule 6 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

OS Other specially protected species

Fauna otherwise in need of special protection to ensure their conservation, and listing is otherwise in accordance with the ministerial guidelines (section 18 of the BC Act).

Published as other specially protected fauna under schedule 7 of the *Wildlife Conservation (Specially Protected Fauna) Notice 2018*.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened fauna or flora.

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. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: 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 rail 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. Such species are in urgent need of further survey.

2 Priority 2: 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. Such species are in urgent need of further survey.

3 Priority 3: 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. Such species are in need of further survey.

4 Priority 4: 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.

[1] The definition of flora includes algae, fungi and lichens
[2]Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

Appendix B : Protected Matters Search Tool

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Australian Government
Department of the Environment and Energy

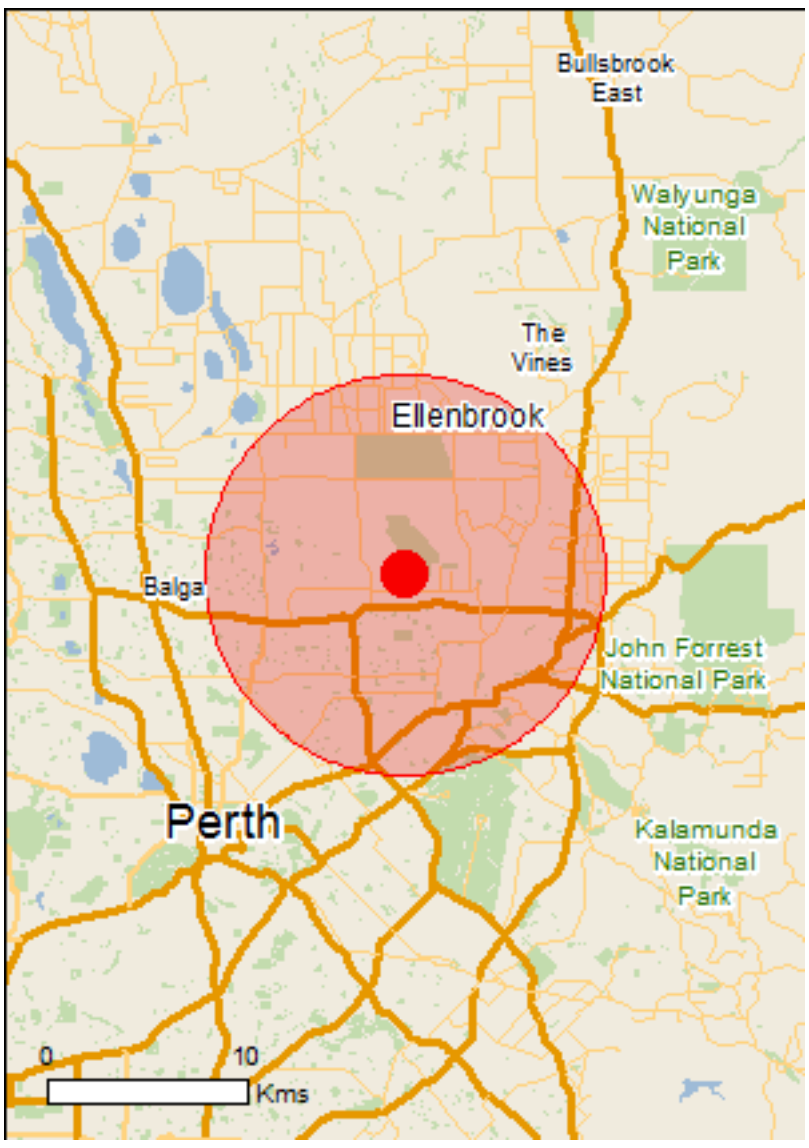
EPBC Act Protected Matters Report

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.

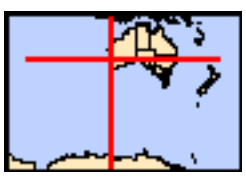
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 19/02/19 14:34:40



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

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:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	51
Listed Migratory Species:	25

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:	3
Commonwealth Heritage Places:	1
Listed Marine Species:	32
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:	2
Regional Forest Agreements:	1
Invasive Species:	44
Nationally Important Wetlands:	3
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

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
Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain	Endangered	Community known to occur within area
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
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely 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	Roosting known to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat 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

Name	Status	Type of Presence
Leipoa ocellata Malleefowl [934]	Vulnerable	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
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat likely to occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	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
Fish		
Galaxiella nigrostriata Blackstriped Dwarf Galaxias, Black-stripe Minnow [88677]	Endangered	Species or species habitat may occur within area
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]	Vulnerable	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 known to occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat may 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 may 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 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 Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species 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
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat may occur within area
Grevillea christineae Christine's Grevillea [64520]	Endangered	Species or species habitat likely to occur within area
Grevillea curviloba subsp. curviloba Curved-leaf Grevillea [64908]	Endangered	Species or species habitat likely to occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat likely to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to 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

Name	Status	Type of Presence
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	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
Trithuria occidentalis Swan Hydatella [42224]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat 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		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely 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
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
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Species or species habitat may 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

Name	Threatened	Type of Presence
		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	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to 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	Species or species habitat known to occur within area
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
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely 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 - PALMER BARRACKS - SOUTH GUILDFORD
Defence - RAAF CAVERSHAM

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Inglewood 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 tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat likely to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat likely 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
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
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 may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat likely to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Species or species habitat may 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
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Mammals		
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Species or species habitat known to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Unnamed WA44853	WA
Unnamed WA46920	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

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

Name	Status	Type of Presence
		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
Capra hircus Goat [2]		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
Feral deer Feral deer species in Australia [85733]		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 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
Sus scrofa Pig [6]		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

Name	Status	Type of Presence
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 sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species 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

Name	Status	Type of Presence within area

Nationally Important Wetlands [Resource Information]

Name	State
Perth Airport Woodland Swamps	WA
RAAF Caversham	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

-31.85001 115.94088

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 B: Desktop review and impact assessment of Subterranean Fauna for the Morley-Ellenbrook Line (Invertebrate Solutions 2019)

MEL-MNO-IS-EN-RPT-0001_0 - IFU

Desktop review and impact assessment of Subterranean Fauna for the Morley-Ellenbrook Line, Perth, Western Australia

Report by Invertebrate Solutions
for Public Transport Authority

August 2019

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Invertebrate Solutions. (2019). Desktop review and impact assessment of subterranean fauna for the Morley-Ellenbrook Line, Perth, Western Australia.

Unpublished report to Public Transport Authority, August 2019.

Report Number 2019ISJ05_F01_20190830

Prepared for: Public Transport Authority, Western Australia

Frontispiece: A stygobiont bathynellid crustacean.

Image copyright Invertebrate Solutions 2019.

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Contents

List of Figures

List of Tables

Executive Summary

The Morley-Ellenbrook Line (MEL), a component of the State government's METRONET program to increase the size of Perth's railway network, will connect the existing Midland Line to Perth's northeast suburbs, terminating in Ellenbrook. The development of the MEL project is being led by the METRONET office, while the Public Transport Authority of Western Australia (PTA) is the project's formal proponent.

Although the MEL alignment has not yet been finalised, a route commencing at Bayswater Station on the Midland Line has been identified (see Figure 1 attached). The approximate 21 kilometre (km) railway will follow the centre median of Tonkin Highway, heading north through the Reid Highway interchange, before leaving the median in Malaga between Marshall Road and Hepburn Avenue. From Malaga, the alignment will turn east across the southern part of Whiteman Park, before heading north along the eastern side of Whiteman Park adjacent to Lord Street. After crossing Gnangara Road, the alignment will follow an existing reservation into the centre of Ellenbrook, terminating near Arbor Drive. The project will include new railway stations at Ellenbrook and other intermediate locations. The vertical alignment of the railway has not yet been confirmed, but may include underpasses, bridges, cuttings and/or raised embankments.

The MEL Project area is situated above the Gnangara Mound that covers much of the north Swan Coastal Plain (from Moore River in the north, the Darling Scarp to the east and the Swan River to the south) and is a significant groundwater resource comprised of four aquifers; the superficial, Mirrabooka, Leederville and the Yarragadee aquifer. The superficial aquifer is largely hosted by the Bassendean Sands and this aquifer is the primary available potential habitat for stygofauna on the Swan Coastal Plain due to its unconfined nature. The Gnangara Mound that occurs throughout the MEL Development Envelope (on the Swan Coastal Plain) is known to contain stygofauna where sampling has occurred, although diversity is not high. Due to the highly uniform nature of the Gnangara Mound within the Bassendean Sands that are present throughout the MEL Project area stygofauna species occurring in the superficial aquifer are likely to be relatively widespread across the northern Swan Coastal Plain.

No troglofauna records from within the Desktop Study area are present. Troglofauna are known to occur within void spaces or fractured geological units, especially where transmissivity is high such as in karst. There is a very low likelihood of troglofauna being present within the Bassendean Sands that is present throughout the MEL Development Envelope due to a lack of interconnected voids.

There is potentially a Low likelihood of overall impact to stygofauna from virtually all aspects of the project. Excavation for the MEL will be the most significant direct impact to stygofauna, however, it is still considered to be a Low overall impact due to the generally shallow depths of excavation. It is anticipated that the majority of impacts will be experienced during ground works, including excavations for underpasses. For both Part 1 and Part 2, no groundwater abstraction will occur thus no drawdown, and hence no impacts to subterranean fauna from the MEL Project is anticipated to occur. Dewatering for construction of underpasses will be temporary and localised (< 1 m depth within 250 m of the excavation) thus indirect impacts to subterranean fauna due to dewatering are not anticipated.

Contamination of groundwater during construction and subsequent use may also impact significantly upon subterranean fauna habitat, but risks of contamination can be minimised by measures included in a Construction Environment Management Plan (CEMP). The potential for contamination during construction is limited to isolated areas of chemical storage and small quantities of hydro carbons where machinery or generators are working. The risk of contamination during operations is minimal as the passenger railway runs off overhead electrified wires rather than stored fuel on the trains themselves. The trains contain only small quantities of transmission oil with minimal risk of contamination impacts.

Cumulative impacts on the Swan Coastal Plain are expected to be minimal as the known subterranean diversity is low compared with other regions of Western Australia (Pilbara and Mid West). The primary cumulative impacts from this development is land clearance and altered hydrology, however, these are relatively small in the scale of northern Swan Coastal Plain.

Given the narrow linear nature of the project, and given the low subterranean habitat values present within the MEL Project Area, it is considered unlikely that the MEL project would result in any significant impacts to subterranean fauna.

1. Introduction

The Morley-Ellenbrook Line (MEL), a component of the State government's METRONET program to increase the size of Perth's railway network, will connect the existing Midland Line to Perth's northeast suburbs, terminating in Ellenbrook. The development of the MEL project is being led by the METRONET office, while the Public Transport Authority of Western Australia (PTA) is the project's formal proponent.

The MEL project is likely to require environmental approvals under the State Environmental Protection Act 1986 (EP Act) and the Commonwealth Environment protection and Biodiversity Conservation Act 1999 (EPBC Act). To support environmental assessments and gain environmental approvals, METRONET has identified a number of additional technical studies to be undertaken, including for subterranean fauna, as defined in this document.

Although the MEL alignment has not yet been finalised, a route commencing at Bayswater Station on the Midland Line has been identified (see Figure 1 attached). The approximate 21 kilometre (km) railway will follow the centre median of Tonkin Highway, heading north through the Reid Highway interchange, before leaving the median in Malaga between Marshall Road and Hepburn Avenue. From Malaga, the alignment will turn east across the southern part of Whiteman Park, before heading north along the eastern side of Whiteman Park adjacent to Lord Street. After crossing Gnangara Road, the alignment will follow an existing reservation into the centre of Ellenbrook, terminating near Arbor Drive. The project will include new railway stations at Ellenbrook and other intermediate locations. The vertical alignment of the railway has not yet been confirmed, but may include underpasses, bridges, cuttings and/or raised embankments.

Due to the potential for impacts to the subsurface environment, including excavation, vegetation clearing and potential changes to surface and subsurface hydrology and the potential for subsequent impacts to subterranean fauna Invertebrate Solutions has been requested by the Public Transport Authority (PTA) to provide a desktop habitat and impact assessment for subterranean fauna (stygofauna and troglofauna) for the MEL (Part 1 and Part 2).

Subterranean fauna are comprised of stygofauna (aquatic subterranean dependent species) and troglofauna (air breathing subterranean dependent species) which are known to be relatively diverse on a worldwide scale in parts of Western Australia. Many species of subterranean fauna have highly restricted ranges, due to habitat connectivity issues and evolutionary history. Stygofauna and troglofauna are known to occur widely in much of Western Australia with many locally endemic species.

The high degree of local endemism and lack of habitat connectivity makes subterranean fauna susceptible to high level impacts from localised projects, with species extinction a real possibility if they are not adequately considered during project planning phases (EPA 2016a).

1.1 Purpose of this report

Invertebrate Solutions has been requested by PTA to undertake a desktop assessment for subterranean fauna in the proposed MEL Development Envelope (Parts 1 and 2) and specifically address the following scope of works:

- Undertake a desktop assessment for subterranean fauna known or likely to occur within the Morley-Ellenbrook Development Envelope.
- Provide information about the about the suitable habitats for stygofauna and troglofauna within the Morley-Ellenbrook Line Development Envelope and in the local area.
- Provide a summary of the potential direct and indirect impacts to subterranean fauna as a result of the project .
- Provide an assessment of the significance of these impacts at a local and regional scale for both Part 1 and Part 2.
- Provide advice on any management and/or mitigation measures that could be implemented.
- Identify any other gaps in the information.
- Provide recommendations and any suggested requirements for further work to comply with relevant legislation.
- Provide a written report containing the above items.

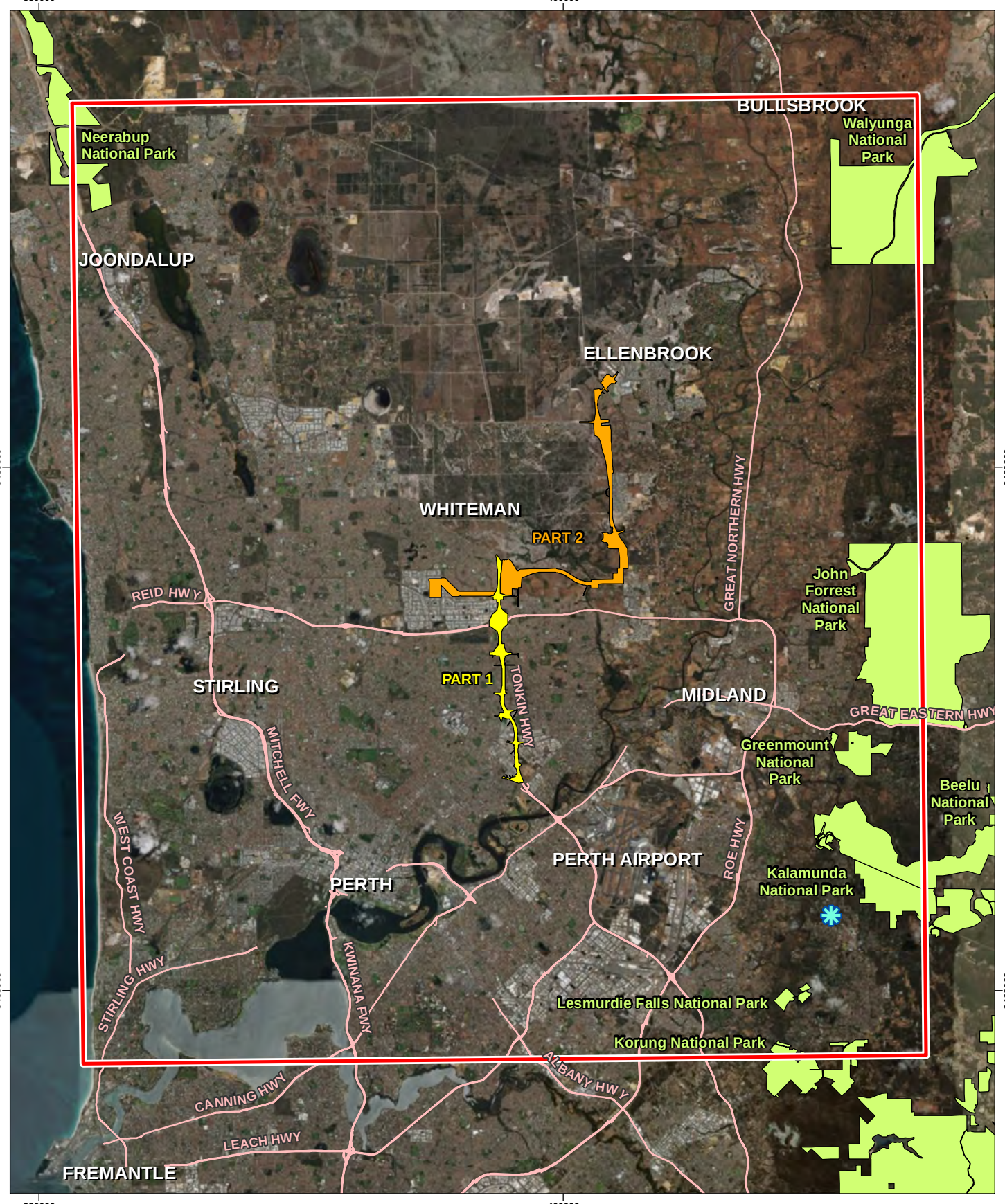
1.2 Desktop Study Area and Project Area

The Desktop Study Area is defined by a rectangle bounded by the northwest corner (-31.683571°S 115.747205°E,) and the southeast corner (-32.015030°S 116.087600°E). The desktop Study Area boundary and the MEL Project Development Envelope (Part 1 and Part 2) are shown in Figure 1. The MEL project footprint is yet to be confirmed, however, it will be entirely constructed and operated within the Development Envelope (Part 1 and 2) shown in Figure 1.

1.3 Documents examined

The following documents have been examined in the compilation of this report, along with other referenced scientific papers used to provide general background:

- Geological Survey of Western Australia (1978). Perth 1:250,000 Sheet SH 50-14 and part of SH 50-13 Geological Map, Geological Survey of Western Australia.
- English V. and Blyth, J. (2000). Interim Recovery Plan Assemblages of Organic Mound (Tumulus) Springs of the Swan Coastal Plain 2000-2003. Conservation and Land Management, Environment Australia, February 2000. Accessed 22nd July 2019 at http://www.environment.gov.au/resource/assemblages-organic-mound-tumulus-springs-swan-coastal-plain-interim-recovery-plan-2000
- Bennelongia (2008). Literature review and monitoring program for stygofauna in the Gnangara Groundwater System. Unpublished report to Department of Environment and Conservation, 19p.
- Bennelongia (2016). Groundwater Replenishment Scheme Stage 2: Subterranean Fauna Desktop Assessment. Unpublished report to Water Corporation, 20p.
- GHD (2010). Report for Murray Wetland Study. Stygofauna Baseline Survey. Unpublished report to the Department of Water, 19p.



Legend

- Desktop Study Area
- National Park
- Road
- *Amphipoda: Hurleya kalamundae* Location

Development Envelope

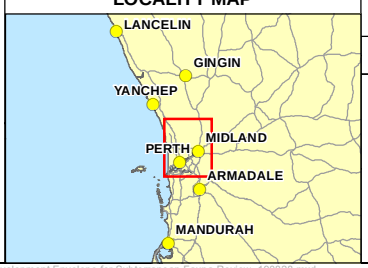
- Part 1 Development Envelope
- Part 2 Development Envelope

- LOCALITY MAP SOURCED FROM LANDGATE 2006
- STREET DIRECTORY MAP SOURCED STREETSMART 2008
- AERIAL PHOTOGRAPHY SOURCED ESRI WORLD IMAGERY

0 1.25 2.5 5
km
Scale: 1:200,000 @ A4

- NOTE THAT POSITION ERRORS CAN BE >5M IN SOME AREAS

LOCALITY MAP



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PROJECT ID	DATE
MELP-SFDR	28/08/2019

HORIZONTAL DATUM AND PROJECTION
GDA 1994 MGA Zone 50

CREATED	CHECKED	APPROVED	REVISION
ENVIRONMAPS	TM	TM	0

Morley-Ellenbrook Line Project
Subterranean Fauna Desktop Report

Figure 1

Desktop Study Area and Development Envelope for Subterranean Fauna Review: Morley-Ellenbrook Line Project

ENVIRONMAPS t: 0406 590 006
Environmental Mapping Solutions www.environmaps.com.au

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C:\GIS\Jobs\Invertebrate Solutions\Morley-Ellenbrook Line Project - Subterranean Fauna Desktop Report\Figures\MELP-SFDR_F01 Desktop Study Area and Development Envelope for Subterranean Fauna Review_190828.mxd

- Ecological Australia (2019). Morley-Ellenbrook Line Environmental Constraints Desktop Analysis. Unpublished report to Public Transport Authority, 164p.

This report has been prepared with regard to the Technical Guidance – subterranean fauna survey (EPA 2016a), Technical Guidance – sampling methods for subterranean fauna (EPA 2016b), and the Environmental Factor Guideline – Subterranean Fauna (EPA 2016c).

1.4 Conservation Legislation and Guidance Statements

Subterranean fauna are protected under state legislation via the newly enacted Biodiversity Conservation (BC) Act (2016) which came into force on 1st January 2019, replacing the outdated Wildlife Conservation (WC) Act (1950). The new BC Act is aligned with the federal Environment Protection and Biodiversity Conservation (EPBC) Act (1999). The assessment of subterranean fauna for environmental impact assessment (EIA) is undertaken in Western Australia with regard to the Technical Guidance – Subterranean Fauna Survey (EPA2016a), Technical Guidance – Sampling Methods for Subterranean Fauna (EPA2016b) and the Environmental Factor Guideline – Subterranean Fauna (EPA 2016c).

At the State level, the BC Act provides a list of species that have special protection as species listed under Part 2 of Biodiversity Conservation Act, 2016. This notice is updated periodically by the Department of Biodiversity, Conservation and Attractions (DBCA) (formerly the Department of Parks and Wildlife (DPaW) and the current list (November 2018) includes numerous subterranean species mainly from the Cape Range and Pilbara regions. Included in the list are crustaceans, arachnids and myriapods that are considered to be "rare or likely to become extinct, as critically endangered fauna, or are declared to be fauna that is in need of special protection" (DPaW 2015). In addition to the specially protected fauna, DBCA also maintains a list of Priority fauna that are considered to be of conservation significance but do not meet the criteria for formal listing under the BC Act. The Priority fauna list is irregularly updated by DBCA and, although it offers no formal legislative protection, these species are generally considered in the EIA process.

The BC Act now provides the ability for the state government of Western Australia to formally list Threatened Ecological Communities (TECs), along with threatening processes. Several subterranean ecological communities are recognised as Threatened including the Bundera Cenote Anchialine community on Cape Range, Cameron's Cave near the townsite of Exmouth on Cape Range, stygal root mat communities in both the Yanchep and Margaret River regions and stygobionts in the Ethel Gorge aquifer in the Pilbara.

The federal EPBC Act protects both species and ecological communities, however, the only listings for subterranean fauna in Western Australia are located on the Cape Range, some 1500 km north of Perth. There are no EPBC listed species or habitats within the Swan Coastal Plain.

1.5 Classifications of subterranean dependence

Subterranean fauna is a collective term that refers to both troglofauna (terrestrial subterranean fauna inhabiting air voids) and stygofauna (aquatic subterranean fauna) (Humphreys 2000). Extensive amounts of jargon have historically been associated with subterranean fauna and multiple forms of classification have been used through time (Sket 2008). The most commonly accepted and used terms divide troglofauna into categories that describe a particular species' degree of

dependence upon the subterranean environment. Due to the reliance upon ecological information to determine if a species is a troglobite, the concept of troglomorphy (Christiansen 1962), specific morphological adaptations to the subterranean environment, is used to define obligate subterranean species. The term troglomorphy, initially confined to morphology has since been used to describe both morphological or behavioural adaptations (Howarth 1973). This combination provides a practical system, easily applied in the field and with minimum of detailed ecological study required (Sket 2008). The level of subterranean dependency for different ecological groupings is described below:

- Troglobiont: animals that are obligate subterranean species, and mostly show morphological adaptation to subterranean habitats (troglomorphisms) including depigmentation, loss or reduction of eyes, elongation of appendages, complete loss of wings or wing reduction, and extra sensory hairs.
- Troglophiles: animals that can complete their entire lifecycle within a cave but possess no specific adaptations to the cave environment. These species are capable of living outside caves in suitably dark and moist epigean habitats.
- Trogloxenes: animals that use the subterranean environment, but require surface environments to complete part of their lifecycle (generally either feeding or breeding). Common trogloxenes are cave dwelling bats, cave swiftlets and cave crickets that leave subterranean habitats to feed.

The terms above refer to stygofauna when the prefix is altered to stygo (Humphreys 2000).

Species which inhabit the deep soil habitat (Edaphophiles) often exhibit convergent morphological adaptations to those animals found exclusively within caves, such as an absence of eyes, body flattening, loss of pigmentation etc. Soil dwelling species commonly do not show highly restricted distributions as they are less easily isolated in evolutionary timeframes, thus only true troglobitic animals are the focus of surveys for subterranean fauna. Taxa discussed in this study were assessed upon their combination of loss/reduction of eyes, and reduction in pigmentation, wing development, and elongation of appendages to assess if a taxa was an edaphophile or truly reliant upon the subterranean habitat (Troglobiont).

1.6 Report Limitations and Exclusions

This study was limited to the written scope provided to the client by Invertebrate Solutions (19th July 2019) and in Section 1.1. This study was limited to the extent of information made available to Invertebrate Solutions at the time of undertaking the work. Information not made available to this study, or which subsequently becomes available may alter the conclusions made herein. Assessment of potential impacts to subterranean fauna was based on proposed development plans provided by the Public Transport Authority.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. Invertebrate Solutions has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by Invertebrate Solutions described in this report (this section and throughout this report). Invertebrate Solutions disclaims liability arising from any of the assumptions being incorrect.

Invertebrate Solutions has prepared this report on the basis of information provided by the Public Transport Authority and others (including Government authorities), which Invertebrate Solutions has not independently verified or checked beyond the agreed scope of work. Invertebrate Solutions does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information. Searches of the Western Australian Museum's database records may not return all species present in a search area as database records are sometimes incomplete, or missing. Invertebrate Solutions does not accept liability in connection with such omissions.

Site conditions may change after the date of this report. Invertebrate Solutions does not accept responsibility arising from, or in connection with, any change to the site conditions. Invertebrate Solutions is also not responsible for updating this report if the site conditions change.

1.7 Assumptions

Invertebrate Solutions has made the following assumptions in the writing of this report and its subsequent conclusions:

- The potential impacts identified and assessed in Section 4 and otherwise throughout this report are not necessarily exhaustive and may change with additional detail regarding the potential development.
- No abstraction of groundwater for construction purposes will be undertaken, resulting in no impacts to regional or local groundwater levels.
- Dewatering for construction of underpasses and structures will be temporary and localised (< 1 m depth within 250 m of the excavation) with no significant impacts to subterranean fauna habitats.

2. Desktop Methods

The subterranean fauna desktop review comprises of two distinct sections:

- An assessment of the likelihood that subterranean species are present in the habitats located within the Desktop Study Area.
- Consideration of the potential impacts to subterranean species that may occur as a result of the proposal.

2.1 Likelihood of Subterranean fauna occurrence

The likelihood of stygofauna and troglofauna species occurring in the MEL Development Envelope was assessed using a combination of regional information, geological, hydrogeological and database searches including:

- Analysis of published and unpublished reports concerning subterranean fauna from the region.
- Available geological maps.
- Geological, geotechnical and hydrogeological information available for the MEL Project Area.
- Results of a Protected Matters Search from the Federal Government's Department of the Environment and Energy (DEE) website.
- Records of fauna held by the Western Australian Museum.

Based on the analysis of all available information the MEL Development Envelope was assigned a level of likelihood to support subterranean fauna of either 'Low', 'Moderate', 'High',' or 'Definite' (Table 1).

Table 1 Subterranean species likelihood of occurrence definitions

Subterranean Fauna Likelihood of occurrence	Definition
Definite	The species/community is confirmed to occur within the Study Area
High	Habitat for the species/community is known to occur within the Study Area and/or known records of the species are within 20 km
Moderate	Habitat for the species/community is known to occur within the Study Area and/or known records of the species are within 50 km
Low	The species/community has been recorded from within 50 km, however, no habitat is present for the species within the Study Area
Very low	No habitat exists for the species/community within the Study Area and no records of the species are within 50 km

2.2 Potential Impacts to Subterranean Fauna

The potential impacts of the installation of infrastructure and general construction activities on subterranean fauna may be categorised as being either direct or indirect impacts.

Direct impacts are the obvious and unavoidable destruction or degradation of habitat that occurs in excavation for footings and other subsurface excavations, including associated aquifer dewatering (EPA 2016a).

Indirect impacts are generally gradational, and more difficult to predict and manage because they may occur at moderate to large distances from the project footprint. These impacts may be expressed some time after development has been undertaken. Some examples include changes to hydrology, nutrient and microclimate regimes, contamination, reduced habitat area, water quality, and population viability. The zone of influence for indirect impacts may be considerably larger than the immediate area of the disturbance area. Potential indirect impacts of development include:

- Alteration of surface hydrology that affects groundwater recharge regimes, sedimentation, and water quality (e.g. under and adjacent to infrastructure areas, roads and hard packed surfaces).
- Reduction in organic inputs beneath areas cleared of vegetation and sealed surfaces.
- Vibration disturbance from construction and operational activities.
- Surface and groundwater contamination from plant equipment and infrastructure (e.g. chemical pollutants, hydrocarbons or waste water of lower quality).
- Changes to subterranean microclimate in rock masses surrounding clearing areas (exposure of subterranean habitat to desiccation).
- Risk of species extinction from reduction and/or fragmentation in habitat.
- Cumulative impacts from nearby developments.

The proposed Project alignment and general project description provided by PTA were reviewed to assess the potential severity of impact to potential subterranean habitats. In evaluating the relevance of these factors to the Project, consideration was given to the magnitude, duration and spatial extent of the impacts, where known. This assessment has taken the approach of considering these broad categories of potential impacts and evaluating their occurrence and relative severity. The impacts were then assigned a level of either ‘Low’, ‘Moderate’, or ‘High’ according to their potential degree to adversely affect the EPA’s objective to maintain representation, diversity, viability and ecological function at the species, population and assemblage level for subterranean fauna.

Where an impact is designated as ‘Low’ no further consideration to this factor is required if all assumptions made throughout this report are correct.

3. Desktop Subterranean Fauna Review

3.1 Subterranean fauna of the Swan Coastal Plain

Knowledge of subterranean fauna within the northern Swan Coastal Plain (from Moore River in the north, the Darling Scarp to the east and the Swan River to the south) is less than the more comprehensively surveyed areas of the Pilbara and Yilgarn. Sporadic surveys for troglofauna have been undertaken from the limestone caves further north at Cervantes and Eneabba from the 1970s to recent years (Moulds 2007a, 2007b, WASG 2016). To the east of the karstic calcarenite coastal band some pilot surveys for stygofauna have been undertaken in other lithologies including quartzite near Moora (Knott and Goater 2005).

Within the northern Swan Coastal Plain the most data are available for the Yanchep Caves, centred around the Yanchep National Park and the aquatic root mat communities associated with root mats from Tuart trees (*Eucalyptus gomphocephala)* in pools and streams fed by groundwater from the Gnangara Mound (Jasinska and Knott 2000, English et. al. 2000). These root mat communities were previously found in six caves (YN99, Cabaret Cave, Carpark Cave, Twilight Cave, Water Cave and, in the past, Gilgie Cave) and although considered a single community, each cave contains at least one species found in no other cave (English et al. 2000), however this karstic habitat is not present within the MEL Study area.

Sampling for stygofauna around Yanchep caves has been undertaken by the late Dr Brenton Knott (University of Western Australia) with many hundreds of samples taken although within the karstc Tamala limestone, however, only very limited diversity was discovered including copepods, amphipods and a few ostracods (Bennelongia 2016).

Stygofauna has been sampled within the superficial Gnangara Mound as part of regional stygofauna sampling (Bennelongia 2008). This sampling has shown that stygofauna do occur within the unconfined surficial aquifer, but with low species richness. A moderately extensive regional sampling program recorded 11 species from within the Gnangara Mound between Guilderton in the north, east to the Darling fault and south to the Swan River (Bennelongia 2008). Further repeated stygofauna sampling of 12 shallow bores in the central Perth suburb of Kensington recorded 21 species with 13 of these considered to be stygofaunal species comprising six copepods, three syncarids, three oligochaetes and one annelid species (Bennelongia 2016). All the species were recorded in very low abundances. These results are similar to those found by hoc basis sampling by WAM staff with only 11 species recorded. Sampling of the deeper confined Leederville and Yarragadee aquifers has also been undertaken by the WAM with no occurrence of stygofauna recorded to date.

Schmidt (2005) found relatively few species in groundwater associated with Marbling Brook on the eastern edge of the Darling Scarp in the Chittering catchment, 60 km north-east of Perth. The total yield from seven groundwater bores sampled 12 times was about 21 species, with most being copepods and only two of the 21 species were considered to be stygobionts. Other animals are either known, or likely to be, widespread.

The southern Swan Coastal Plain was sampled by GHD (2010) as part of a drainage and water management plan for the Murray River catchment for the then Western Australian Department of Water (now Department of Water and Environment Regulation (DWER)). The regional survey for stygofauna within the superficial aquifer in the Shire of Murray sampled 20 bores from five different wetland areas and recorded stygofauna from two bores during a single phase sampling survey. A single new species of cyclopoid copepod (*Mixocyclops* sp. nov.) and two species of parabathynellid? were recorded. The copepod specimens from near Pinjarra are closely related to species recorded from Yanchep National Park in the north of the Swan Coastal Plain (GHD 2010).

Troglofauna are known to occur throughout the karstic areas of the coastal Tamala Limestones (Moulds 2007a, 2007b). These are moderately diverse when considering total faunal assemblages (troglobionts and no-troglobionts) although the diversity of troglobionts is low. Several species of troglofauna do appear to be restricted in range to this limestone band although sampling at a regional scale has been ad hoc and further research is required to confirm this. No troglofauna are known from the unconsolidated Bassendean and Pinjarra Sands that lie to the east of the karstic limestone band near the coast.

3.2 Conservation Significant Fauna and Habitats

A list of conservation significant fauna for the Study Area was compiled from the DBCA Wildlife Conservation (Specially Protected Fauna) Notice 2019 (DBCA 2019) and the Protected Matters Search Tool (PMST) of the Australian Government's Department of the Environment and Energy (DEE). No subterranean species that are listed under the WC Act and/or the EPBC Act are likely to occur or have known habitat within the Desktop Study Area are. The PMST results listed no known subterranean fauna within the Desktop Study Area. A full description of the BC Act and DBCA conservation codes are shown in Appendix 1. The full list of species obtained from the PMST search is shown in Appendix 2.

Table 2 Listed TECs relevant to the subterranean environment within the Desktop Study Area.

Name	Category	Description	Likelihood of occurrence within the MEL Project Area
Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain	**Critically Endangered ecological community (*BC Act*) / Endangered (*EPBC Act*)**	The tumulus springs historically occurred where the Bassendean sands and the clay soils of the Guildford Formation clays meet forcing groundwater from the Gnangara Mound to the surface forming springs, bogs, and swamps. Tumulus springs exhibit continuous growth and breakdown of vegetation that causes the formation of peat around the permanent water supply. Water continues to penetrate the increasingly elevated peat layers due to the pressure created by local and regional hydrological forces. The peat and surrounds provide a stable, permanently moist series of microhabitats. Intact vegetated tumulus springs are only found at three locations. Not explicitly associated with stygobionts or stygophilic species with restricted ranges	Does not occur in the Part 1 MEL Project Area The northern extremity of Part 2 of the MEL Project area is within the TEC buffer.

The Desktop Study Area contains a single Threatened Ecological Community (TEC) that relates to the subterranean environment (Table 2, Appendix 2, DEE 2019). The Tumulus Mound Spring and

associated flora and invertebrate assemblage is listed as Critically Endangered (BC Act) and Endangered (EPBC Act). Vegetation mapping by RPS (2018) identified three potential occurrences of this TEC within the MEL Project Part 2 area although subsequent advice from DBCA stated that none of these occurrences represented the TEC. The nearest known occurrence of this TEC is one kilometre to the northeast of the MEL Project area in Ellenbrook, with the northernmost part of the MEL Development Envelope intersecting the record's buffer (Ecological 2019).

Mound springs in general often contain some groundwater associated species, however these are rarely obligate stygobionts and the Tumulus Mound Springs of the eastern Swan Coastal Plain contains no obvious stygobionts nor species with restricted ranges (Bennelongia 2008 and references therein).

3.3 Subterranean Fauna Habitat in the MEL Project Area

The broad Desktop Study Area encompasses the unconsolidated sands of the Bassendean Dune system and the Guildford Formation. The MEL Project area is at least 35 km to the east of the karstic Tamala Limestone that generally underlies the Spearwood Dune system (Playford et al. 1976) that also provides the highest likelihood of subterranean fauna on the Swan Coastal Plain. The MEL Project is situated entirely within the Bassendean sands that provide limited habitat potential for subterranean fauna due to their unconsolidated nature and lack of interstitial voids.

The MEL Project area is situated above the Gnangara Mound that covers much of the north Swan Coastal Plain and is a significant groundwater resource comprised of four aquifers; the superficial, Mirrabooka, Leederville and the Yarragadee aquifer (Golder 2015). The superficial aquifer is largely hosted by the Bassendean Sands and this aquifer is the primary available potential habitat for stygofauna on the Swan Coastal Plain (refer to previous sampling on the Swan Coastal Plain in Section 3.1) due to its unconfined nature. The superficial aquifer reaches a maximum depth of 70m but averages between 20 – 45 m (Davidson 1995).

The Yarragadee aquifer is a confined aquifer and the deepest of the three aquifers (Gnangara Mound and Leederville Aquifer) that combine to form the Yarragadee formation. The Yarragadee formation is comprised of poorly sorted sandstones that are highly porous and can therefore store large amounts of water also making it prospective habitat for stygofauna. No published results for any stygofauna sampling is available for the deeper Yarragadee aquifer.

Table 3 Geological units in the MEL Project Development Envelope and their Subterranean fauna habitat potential.

Geological Unit	Description / Remarks	Subterranean Fauna Habitat Suitability
Bassendean Sands	Bassendean sands are typically pale grey to white quartz sands with layers of iron cemented sand known as "coffee rock" dispersed throughout.	Low for stygofauna Very low for troglofauna.
Guildford Formation	Alluvium (Sand, loam clay and gravel), laterised lenses	Low for stygofauna and troglofauna.

Geological Unit	Description / Remarks	Subterranean Fauna Habitat Suitability
Leederville Formation	Interbedded sandstone, siltstone and shales	Low for stygofauna. Very Low for troglofauna.
Yarragadee Formation	Sandstone and conglomerate	Low for stygofauna. Very Low for troglofauna.

3.4 Likelihood of stygofauna presence

A search was undertaken of the Western Australian Museum databases for Crustaceans (WAM 2018a) and Arachnids/Myriapods (WAM 2018b). The searches were undertaken as a rectangle centred on the Project Development Envelope (31.683571°S 115.747205°E, 32.015030°S 116.087600°E). The results of these filtered for subterranean stygofauna species are shown in Table 4.

Two stygofauna species are present within the MEL Desktop Study Area, a widespread and ubiquitous copepod *Paracyclops fimbriatus* and a highly restricted species of Amphipod, *Hurleya kalamundae* that is known from a single bore within the Guildford formation at Kalamunda over 12 km from the MEL Project Area. The stygofauna records contained within the WAM Crustacean Department database is shown in Table 4 is invariably not complete with many records listed in unpublished survey reports either absent or incomplete.

The Gnangara Mound that occurs throughout the MEL Development Envelope (on the Swan Coastal Plain) is known to contain stygofauna where sampling has occurred (Bennelongia 2008, 2016), although diversity is not high. Due to the highly uniform nature of the Gnangara Mound within the Bassendean Sands that are present throughout the MEL Project area stygofauna species occurring in the superficial aquifer are likely to be relatively widespread across the northern Swan Coastal Plain (Bennelongia 2008, 2016). Stygofauna species with restricted distributions are more likely to be associated with specific karst features associated with the Tamala Limestone outcrops including Yanchep National Park (Jasinska and Knott 2000, Invertebrate Solutions 2018). This is demonstrated by sampling in the Gnangara Mound that recorded 14 species of groundwater associated copepods (Tang and Knott 2009) of which only two species showed restricted distributions to either karstic springs or caves (Bennelongia 2016).

No stygofauna sampling has previously occurred in the deeper Yarragadee formation, although physical habitat may be present, energy and other requirements for stygofaunal communities may not be suitable.

The deeper confined aquifers of the Leederville and Yarragadee are unlikely to contain stygofauna due to the limited carbon and energy inputs available from the surface.

Table 4 Stygofauna in WAM databases recorded from within the Desktop Study Area.

Order	Family	Genus and Species	Known occurrence within Study Area	Likelihood of occurrence within the MEL Development Envelope
Amphipoda	Paramelitidae	*Hurleya* kalamundae	Kalamunda	Low

Order	Family	Genus and Species	Known occurrence within Study Area	Likelihood of occurrence within the MEL Development Envelope
Copepoda	Cyclopidae	*Paracyclops fimbriatus*	Groundwater monitoring wells – Widespread throughout Australia	High

3.5 Likelihood of troglofauna presence

A search was undertaken of the Western Australian Museum databases for Crustaceans (WAM 2019a) and Arachnids/Myriapods (WAM 2019b). The searches were undertaken as a rectangle centred on the Project Development Envelope (31.683571°S 115.747205°E, 32.015030°S 116.087600°E). No troglofauna records from within the Desktop Study area are present.

Troglofauna are known to occur within void spaces or fractured geological units, especially where transmissivity is high such as in karst. There is a very low likelihood of troglofauna being present within the Bassendean Sands that is present throughout the MEL Development Envelope due to a lack of interconnected voids.

4. Subterranean Fauna Preliminary Impact Assessment

This preliminary impact assessment is based primarily upon and the project components as outlined by the PTA with the main components of the overall project consist of the following:

- A route commencing at Bayswater Station on the Midland Line has been identified (see Figure 1).
- The approximate 21 kilometre (km) railway will follow the centre median of Tonkin Highway, heading north through the Reid Highway interchange, before leaving the median in Malaga between Marshall Road and Hepburn Avenue.
- From Malaga, the alignment will turn east across the Marshall Road Paddocks, before heading north along the eastern side of Whiteman Park adjacent to Lord Street.
- After crossing Gnangara Road, the alignment will follow a dedicated transit corridor into the centre of Ellenbrook, terminating near Arbor Drive.
- The project will include new railway stations at Ellenbrook and other intermediate locations.
- The vertical alignment of the railway has not yet been confirmed, but may include underpasses, bridges, cuttings and/or raised embankments.

4.1 Groundwater impacts

For both Part 1 and Part 2, no groundwater abstraction will occur thus no drawdown, and hence no impacts to subterranean fauna from the MEL Project is anticipated to occur.

Dewatering for construction of underpasses and structures will be temporary and localised (< 1 m depth within 250 m of the excavation) thus indirect impacts to subterranean fauna due to dewatering are not anticipated.

4.2 Local impacts during construction and operation

The potential direct and indirect impacts to subterranean fauna within the MEL Development Envelope are summarised in Table 5 and Table 6. The assessment of the overall impact to subterranean fauna from each disturbance mechanism takes into account both the likelihood of the impact occurring, its duration and severity. The local geology of Bassendean Sands throughout the MEL Project Area, provides no troglofauna habitat (and no records of troglofauna are present within the Desktop Study Area), and indicates limited habitat for stygofauna with the overall diversity and abundance of stygofauna within the Gnangara Mound being low (Bennelongia 2008, 2016). Given the narrow linear nature of the project, and given similar subterranean habitat values are present widely throughout the Gnangara Mound, it is considered very unlikely that the MEL project would result in any significant impacts to subterranean fauna.

Impacts that have been assessed as being Low risk to subterranean fauna combined with a low likelihood of occurrence such as Piling and drilling, alteration of hydrological regimes, vibration risk and habitat fragmentation are not considered further.

No impacts, either direct or indirect, to troglofauna are anticipated due to the absence of troglofauna habitat throughout the MEL Development Envelope (Part 1 and Part 2).

Direct impacts

Excavation for the MEL will be the most significant direct impact to stygofauna, however, it is still considered to be a Low overall impact due to the generally shallow depths of excavation. It is anticipated that the majority of impacts will be experienced during ground works, including excavations for underpasses, where the maximum depth of excavation from the natural surface is anticipated to be 5 m or less in most locations. No water abstraction for construction purposes will be undertaken, and dewatering for construction purposes will be temporary and localised (< 1 m depth within 250 m of the excavation) thus indirect impacts to subterranean fauna due to dewatering are not anticipated.

Table 5 Risk of direct impacts to subterranean fauna from MEL Project development works

Direct disturbance mechanism	Risk of Impact to Stygofauna Community within MEL Development Envelope	Assessment of overall potential impact to subterranean fauna
Excavation works	Low	Low
Piling/drilling works	Low	Low
Groundwater contamination due to spills during earth and construction works	Low	Low
Groundwater contamination due to spills during operations	Low	Low

Indirect impacts

Clearing of vegetation is an indirect impact that will reduce the amount of organic carbon that enters the subterranean environment that acts as a primary energy source for the subterranean environment. This indirect impact will be mitigated by the potential for winter rain events to wash vegetative material from outside cleared portions of the MEL Project Development Envelope into the subterranean environment. The clearing of native vegetation on the surface from the MEL Project is unlikely to pose significant impact to subterranean fauna due to the very limited clearing footprint in relation to the potential extent of subterranean fauna and habitat and hence the risk of this impact is considered low.

The alteration of surface and subsurface hydrology from excavation and construction of roads, buildings and other hard stand areas may potentially increase sedimentation into the subsurface environment. These indirect impacts have the potential to have a Low impact upon stygofauna by filling or reducing interconnected void spaces, although due to appropriate stormwater design incorporating Water Sensitive Urban Design initiatives and the implementation of a CEMP the overall severity is considered to be Low.

Contamination of groundwater during construction and operations may also impact significantly upon subterranean fauna habitat, but risks of contamination can be minimised by employing management and mitigation measures to minimise and prevent contamination of groundwater. The potential for contamination during construction is limited to isolated areas of chemical storage and

small quantities of hydro carbons where machinery or generators are working. Risks will be minimised by measures included in a CEMP. The risk of contamination during operations is minimal as the passenger railway runs off overhead electrified wires rather than stored fuel on the trains themselves. The trains contain only small quantities of transmission oil with minimal risk of contamination impacts. Where management measures are implemented, the risk of hydrocarbon contamination to subterranean fauna is anticipated to be Low.

Vibration and noise from the construction and ongoing operation of the rail line is expected to be minimal, especially beyond the immediate vicinity of the rail line itself. These impacts are considered to be Low.

Table 6 Risk of indirect impacts to subterranean fauna from MEL Project development works

Indirect disturbance mechanism	Risk of Impact to Stygofauna Community within MEL Development Envelope	Assessment of overall potential impact to subterranean fauna
Vegetation clearing reducing amount of organic carbon entering the subterranean environment	Low	Low
Alteration of existing hydrological regimes due to the construction of roads, buildings and other hard stand areas that will restrict the infiltration of water into the subterranean environment.	Low	Low
Vibrations due to excavations/piling/operation of machinery	Low	Low
Vibrations due to ongoing rail operation	Low	Low
Alteration of surface hydrology that affects, sedimentation, and water quality (e.g. under and adjacent to infrastructure areas, roads and hard packed surfaces).	Low	Low
Changes to subterranean microclimate in rock masses surrounding clearing areas	Low	Low
Risk of species extinction from reduction and/or fragmentation in habitat.	Low	Low

4.3 Regional significance and cumulative impacts

Diversity of subterranean fauna is generally very low per bore on the Swan Coastal Plain with less than five species recorded from any single bore, whilst bores in the Mid West and Pilbara region can support upwards of 30 to 50 species in some cases (Bennelongia 2008, Humphreys 2008, GHD 2010, Guzik et al. 2010). Stygofauna diversity is, however, very sensitive to sampling effort (Allford et al. 2008) and so additional sampling may find higher diversity in some areas of the Swan Coastal Plain. Many of the subterranean species previously recorded in other surveys are undescribed and it is likely that further undescribed, possibly restricted species occur, particularly among groups such as amphipods and isopods, and some of these may have significant conservation values (Bennelongia 2008, GHD 2010). Given the narrow linear nature of the project, and given similar subterranean habitat values are present widely throughout the Gnangara Mound, it is considered unlikely that the MEL project would result in significant impacts.

Cumulative impacts including additional urban developments on the Swan Coastal Plain are expected to be minimal as the known subterranean diversity is low compared with other regions of Western Australia (Pilbara and Mid-West). The primary cumulative impacts from this development is land clearance and altered hydrology, however, these developments are relatively small in the scale of northern Swan Coastal Plain, so cumulative impacts are assessed as being low. Due to the majority of METRONET projects occurring within already largely developed parts of the Swan Coastal Plain, and their narrow linear nature, no significant cumulative impacts are anticipated to occur to subterranean fauna from their development. No abstraction of groundwater from the superficial aquifer for construction purposes will occur and any construction dewatering will be localised and temporary, thus not resulting in a significant reduction in regional or local groundwater levels. It is not anticipated that the MEL Project will add significantly to the cumulative impacts to subterranean fauna in the local or regional areas.

5. Conclusions and Recommendations

The Study Area contains no significant subterranean fauna habitat due to its location entirely within the Bassendean Sands unit of the Swan Coastal Plain, that provides no habitat for troglofauna and only supports limited stygofauna diversity with low abundance. The Study Area contains no Threatened or Priority Ecological Communities that directly relate to subterranean fauna.

There is potentially a Low likelihood of overall impact to stygofauna and troglofauna from virtually all aspects of the project. For both Part 1 and Part 2, no groundwater abstraction will occur thus no drawdown, and hence no impacts to subterranean fauna from the MEL Project is anticipated to occur. Dewatering for construction of underpasses will be temporary and localised (< 1 m depth within 250 m of the excavation) thus indirect impacts to subterranean fauna due to dewatering are not anticipated. Contamination of groundwater during Project construction and operations may impact upon subterranean fauna habitat, but risks of unexpected spills or contamination will be minimised by management and mitigation measures through the construction and operation of the project.

Cumulative impacts on the Swan Coastal Plain are expected to be minimal as the known subterranean diversity is low compared with other regions of Western Australia (Pilbara and Mid West). The primary cumulative impacts from this development is land clearance and altered hydrology, however, these are relatively small in the scale of northern Swan Coastal Plain.

Given the narrow linear nature of the project, and given similar subterranean habitat values are present widely throughout the Gnangara Mound, it is considered unlikely that the MEL project would result in significant impacts.

6. References

Allford A, Cooper SJB, Humphreys WF, Austin AD (2008). Diversity and distribution of groundwater fauna in a calcrete aquifer: does sampling method influence the story? Invertebrate Systematics 22: 127–138.

Bennelongia (2008). Literature review and monitoring program for stygofauna in the Gnangara Groundwater System. Unpublished report to Department of Environment and Conservation, 19p.

Bennelongia (2016). Groundwater Replenishment Scheme Stage 2: Subterranean Fauna Desktop Assessment. Unpublished report to Water Corporation, 20p.

Christiansen, K. A. (1962). Proposition pour la classification des animaux cavernicoles. Spelunca Mem. 2: 76-78.

Davidson, W.A. (1995). Hydrogeology and Groundwater Resources of the Perth Region, Western Australia. Western Australia Geological Survey Bulletin 142, 257p.

Ecological Australia (2019). Morley-Ellenbrook Line Environmental Constraints Desktop Analysis. Unpublished report to Public Transport Authority, 164p.

English V, Blyth, J., Jasinska, E., et al. (2000). Interim Recovery Plan Aquatic Root Mat Community of Caves of the Swan Coastal Plain 2000-2003. Conservation and Land Management, Environment Australia, November 2000. Accessed 6th March 2018 at www.environment.gov.au/resource/interim-recovery-plan-aquatic-root-mat-community-caves-swan-coastal-plain-2000-2003

EPA (2016a). Technical guidance subterranean fauna survey. Environmental Protection Authority: Perth. 24 pp.

EPA (2016b). Technical guidance Sampling methods for subterranean fauna. Environmental Protection Authority: Perth. 37 pp.

EPA (2016c). Environmental factor guideline. Subterranean Fauna. Environmental Protection Authority: Perth. 5 pp.

Geological Survey of Western Australia (1978). Perth 1:250,000 Sheet SH 50-14 and part of SH 50-13 Geological Map, Geological Survey of Western Australia.

GHD (2010). Report for Murray Wetland Study. Stygofauna Baseline Survey. Unpublished report to the Department of Water, 19p.

Golder Associates (2015). Design groundwater level for Central section of Northlink WA road alignment. Unpublished report to Main Roads Western Australia, p134.

Guzik, M.T., Austin, A.D., Cooper, S.J.B., Harvey, M.S., Humphreys, W.F., Bradford, T., Eberhard, S.M., King, R.A., Leys, R., Muirhead, K.A. and Tomlinson, M. (2010). Is the Australian subterranean fauna uniquely diverse? Invertebrate Systematics 24: 407–418.

Halse S.A., Scanlon M.D., Cocking J.S., Barron H.J., Richardson J.B. and Eberhard S.M. (2014). Pilbara stygofauna: deep groundwater of an arid landscape contains globally significant radiation of biodiversity. Records of the Western Australian Museum, Supplement 78: 443–483

Howarth, F. G. (1973). The cavernicolous fauna of Hawaiian lava tubes, 1. Introduction. Pacific Insects 15: 139-151.

Humphreys, W.F. (1999). Relict stygofaunas living in sea salt, karst and calcrete habitats in arid northwestern Australia contain many ancient lineages. In: The other 99%. The conservation and biodiversity of invertebrates. Ed W. Ponder and D. Lunney Transactions of the Royal Zoological Society of New South Wales, Mosman. Pp.219-227

Humphreys, W. F. (2000). Background and glossary. Ecosystems of the world. Subterranean ecosystems. Wilkens, H., Culver, D. C. and Humphreys, W. F. Amsterdam, Elsevier. 30: 3-14.

Humphreys, W.F. (2008). Rising from Down Under: developments in subterranean biodiversity in Australia from a groundwater fauna perspective. Invertebrate Systematics 22: 85–101.

Moulds, T.A. (2007a). Subterranean fauna of the Eneabba, Jurien and South Hill River (Nambung) karst areas, Western Australia. Unpublished report to the Department of Environment and Conservation Mid West Region, 27p.

Moulds, T.A. (2007b). October sampling of subterranean invertebrate fauna of the Eneabba, Jurien and South Hill River (Nambung) karst areas, Western Australia. Unpublished report to the Department of Environment and Conservation Mid West Region, 10p.

Ortuño VM, Gilgado JD, Jiménez-Valverde A, Sendra A, Pérez-Suárez G, Herrero-Borgoñón JJ. (2013). The "Alluvial Mesovoid Shallow Substratum", a New Subterranean Habitat. PLoS ONE 8(10): e76311. doi:10.1371/journal.pone.0076311

Playford, P.E., Cockbain, A.E., Low, G.H. (1976). Geology of the Perth Basin, Western Australia. Western Australian Geological Survey Bulletin 124.

RPS (2018). Detailed Flora and Vegetation Assessment: METRONET Ellenbrook Alignment. Unpublished report to the Public Transport Authority.

Western Australian Museum (WAM). (2019a). Crustacean database search, July 2019.

Western Australian Museum (WAM). (2019b). Arachnida and Myriapoda database search, July 2019.

Western Australian Speleological Group (Inc.) (WASG). (2016). Eneabba caves and cave fauna. http://wasg.org.au/index.php/2015-09-05-08-05-32/eneabba/eneabba-description (Accessed 2 August 2019)

Appendix 1

Department of Parks and Wildlife Conservation Codes (November 2015)

Department of Parks and Wildlife

CONSERVATION CODES

For Western Australian Flora and Fauna

Specially protected fauna or flora are species* which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.

Categories of specially protected fauna and flora are:

T **Threatened species**

Published as Specially Protected under the *Wildlife Conservation Act 1950,* and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act.

Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR **Critically endangered species**

Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EN **Endangered species**

Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

VU **Vulnerable species**

Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EX **Presumed extinct species**

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.

IA **Migratory birds protected under an international agreement**

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.

CD Conservation dependent fauna

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna

Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

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. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: 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 rail 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. Such species are in urgent need of further survey.

2 Priority 2: 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. Such species are in urgent need of further survey.

3 Priority 3: 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. Such species are in need of further survey.

4 Priority 4: 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.

*Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

Appendix 2

Protected Matters Search Tool results

Australian Government
Department of the Environment and Energy

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.

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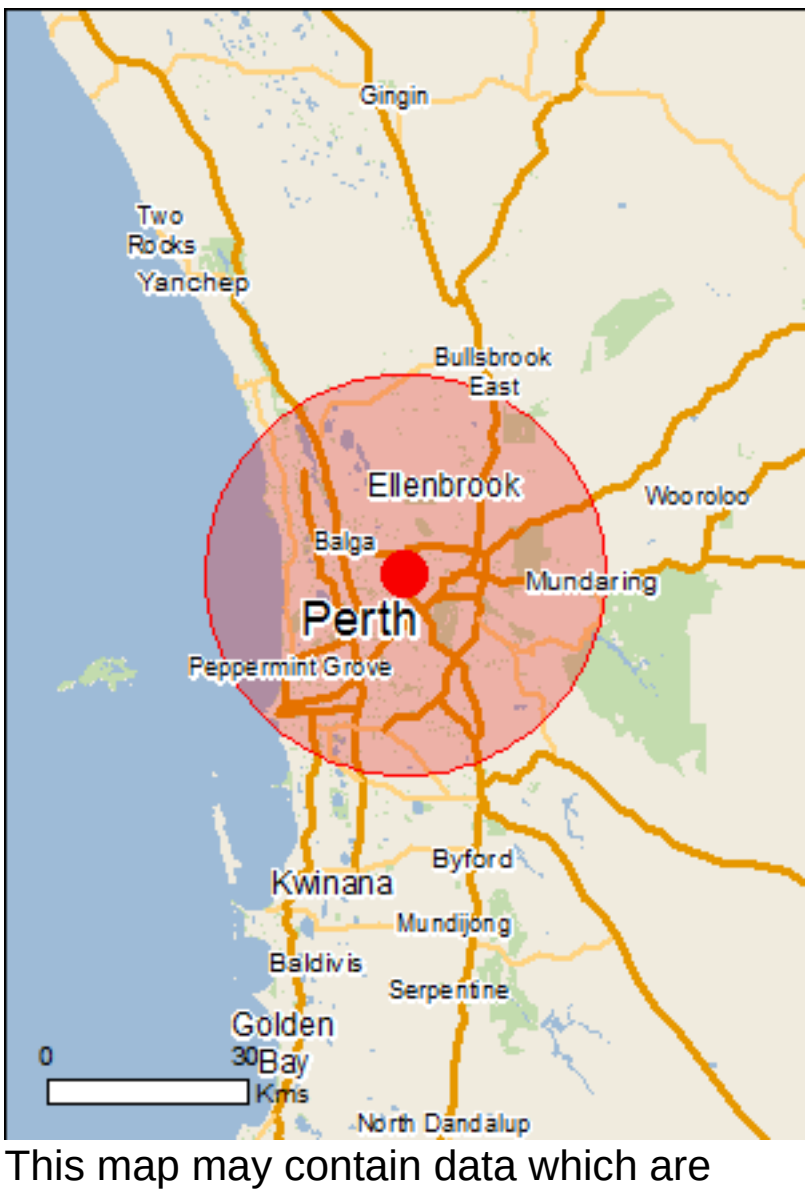

This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

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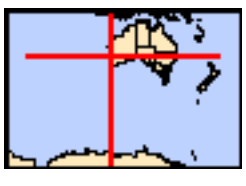

Summary

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:	2
National Heritage Places:	2
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	9
Listed Threatened Species:	99
Listed Migratory Species:	67

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:	27
Commonwealth Heritage Places:	7
Listed Marine Species:	103
Whales and Other Cetaceans:	12
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:	59
Regional Forest Agreements:	1
Invasive Species:	47
Nationally Important Wetlands:	11
Key Ecological Features (Marine)	2

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Status
Australian Convict Sites (Fremantle Prison Buffer Zone)	WA	Buffer zone
Australian Convict Sites (Fremantle Prison)	WA	Declared property

National Heritage Properties [Resource Information]

Name	State	Status
Historic		
Fremantle Prison (former)	WA	Listed place
Goldfields Water Supply Scheme, Western Australia	WA	Listed place

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Forrestdale and thomsons lakes	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-west

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
Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain	Endangered	Community known to occur within area
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
Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain	Endangered	Community known to occur within area
Shrublands and Woodlands of the eastern Swan Coastal Plain	Endangered	Community known to occur within area
Shrublands and Woodlands on Muchea Limestone 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 may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence

Name	Status	Type of Presence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
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	Roosting known 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 leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica baueri Bar-tailed Godwit (baueri), Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Bar-tailed Godwit (menzbieri) [86432]	Critically Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
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
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta cauta Shy Albatross, Tasmanian Shy Albatross [82345]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche cauta steadi White-capped Albatross [82344]	Vulnerable	Foraging, feeding or related behaviour 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
Fish		
Galaxiella nigrostriata Blackstriped Dwarf Galaxias, Black-stripe Minnow [88677]	Endangered	Species or species habitat known 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
Neopasiphae simplicior A native bee [66821]	Critically Endangered	Species or species habitat likely to occur within area
Mammals		
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
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
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat known to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Translocated population 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
Setonix brachyurus Quokka [229]	Vulnerable	Species or species habitat known to occur within area
Other		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat known to occur within area
Plants		
Acacia anomala Grass Wattle, Chittering Grass Wattle [8153]	Vulnerable	Species or species habitat known to occur within area
Acacia aphylla Leafless Rock Wattle [13553]	Vulnerable	Species or species habitat known to occur within area
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 likely to occur within area
Anthocercis gracilis Slender Tailflower [11103]	Vulnerable	Species or species habitat known to occur within area
Austrostipa bronwenae [87808]	Endangered	Species or species habitat known to occur within area
Austrostipa jacobsiana [87809]	Critically Endangered	Species or species habitat known to 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	Endangered	Species or species

Name	Status	Type of Presence
Spider-orchid [7309]		habitat known to occur within area
Calytrix breviseta subsp. breviseta Swamp Starflower [23879]	Endangered	Species or species habitat known to occur within area
Chamelaucium sp. Gingin (N.G.Marchant 6) Gingin Wax [88881]	Endangered	Species or species habitat may occur within area
Conospermum densiflorum subsp. unicephalatum One-headed Smokebush [64871]	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
Darwinia apiculata Scarp Darwinia [8763]	Endangered	Species or species habitat known to occur within area
Darwinia foetida Muchea Bell [83190]	Critically Endangered	Species or species habitat known to occur within area
Diplolaena andrewsii [6601]	Endangered	Species or species habitat known to 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 known to occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat known to occur within area
Drakaea micrantha Dwarf Hammer-orchid [56755]	Vulnerable	Species or species habitat known to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat known to occur within area
Eremophila glabra subsp. chlorella [84927]	Endangered	Species or species habitat known to occur within area
Eucalyptus argutifolia Yanchep Mallee, Wabling Hill Mallee [24263]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus leprophloia Scaly Butt Mallee, Scaly-butt Mallee [56712]	Endangered	Species or species habitat may occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat likely to occur within area
Goodenia arthrotricha [12448]	Endangered	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Grevillea althoferorum [64906]	Endangered	Species or species habitat likely to occur within area
Grevillea christineae Christine's Grevillea [64520]	Endangered	Species or species habitat known to occur within area
Grevillea corrugata a shrub [65445]	Endangered	Species or species habitat likely to occur within area
Grevillea curviloba subsp. curviloba Curved-leaf Grevillea [64908]	Endangered	Species or species habitat known to occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat known to occur within area
Grevillea flexuosa Zig Zag Grevillea [2957]	Vulnerable	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
Lasiopetalum pterocarpum Wing-fruited Lasiopetalum [64922]	Endangered	Species or species habitat may occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Macarthuria keigheryi Keighery's Macarthuria [64930]	Endangered	Species or species habitat likely to occur within area
Marianthus paralius [83925]	Endangered	Species or species habitat known to occur within area
Melaleuca sp. Wanneroo (G.J. Keighery 16705) [89456]	Endangered	Species or species habitat may occur within area
Ptilotus pyramidatus Pyramid Mulla-mulla [18216]	Critically Endangered	Species or species habitat known to occur within area
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat known to occur within area
Synaphea sp. Serpentine (G.R. Brand 103) [86879]	Critically Endangered	Species or species habitat may occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat known to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat known to occur within area
Trithuria occidentalis Swan Hydatella [42224]	Endangered	Species or species habitat likely to occur within area

Name	Status	Type of Presence
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
Pseudemydura umbrina Western Swamp Tortoise [1760]	Critically Endangered	Translocated population known to occur within area
Sharks		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may 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
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat may occur within area
Diomedea dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Hydroprogne caspia Caspian Tern [808]		Foraging, feeding or related behaviour 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
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	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 carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour 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*	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Breeding known to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
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

Name	Threatened	Type of Presence
		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
[Megaptera novaeangliae](#) Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
[Natator depressus](#) Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
[Orcinus orca](#) Killer Whale, Orca [46]		Species or species habitat may occur within area
[Rhincodon typus](#) Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
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 subminuta](#) Long-toed Stint [861]		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

Name	Threatened	Type of Presence
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	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
Philomachus pugnax Ruff (Reeve) [850]		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
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting 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 - ARTILLERY BARRACKS - FREMANTLE
Defence - BUSHMEAD RIFLE RANGE
Defence - BUSHMEAD TRAINING AREA
Defence - CAMPBELL BARRACKS - SWANBOURNE
Defence - EAST FREMANTLE SMALL CRAFT BASE
Defence - HOLDFAST BARRACKS
Defence - IRWIN BARRACKS - KARRAKATTA
Defence - LEEUWIN BARRACKS - EAST FREMANTLE
Defence - MUCHEA ARMAMENT RANGE
Defence - PALMER BARRACKS - SOUTH GUILDFORD
Defence - PEARCE - AP11OBSTRUCTION BEACON NO.5
Defence - PEARCE - AP15 WATER TREATMENT PLANT
Defence - PEARCE - AP17 WATER SUPPLY TANKS
Defence - PEARCE - AP19 HF RECEIVER STATION BULLSBROOK
Defence - PEARCE - AP3 RADAR STATION BULLSBROOK
Defence - PEARCE - AP4 AERIAL FARM
Defence - PEARCE - AP5 OPERATIONS SITE
Defence - PEARCE - AP8 BORE SITES
Defence - PEARCE - AP9 OBSTRUCTION BEACON NO.4
Defence - PEARCE - RAAF BASE
Defence - PRESTON POINT TRAINING DEPOT
Defence - RAAF CAVERSHAM
Defence - SWAN BARRACKS
Defence - SWANBOURNE RIFLE RANGE
Defence - VACANT LAND - BULLSBROOK AP102

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Army Magazine Buildings Irwin Barracks	WA	Listed place
Artillery Barracks	WA	Listed place
Claremont Post Office	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
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Ardea alba Great Egret, White Egret [59541]		Breeding known to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may 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 subminuta Long-toed Stint [861]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius dubius Little Ringed Plover [896]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	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 dabbenena Tristan Albatross [66471]	Endangered	Species or species habitat may occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour 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
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may 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
Larus pacificus Pacific Gull [811]		Foraging, feeding or related behaviour may 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
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

Name	Threatened	Type of Presence
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may 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
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely 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 likely to occur within area
Sterna anaethetus Bridled Tern [814]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Foraging, feeding or related behaviour known to occur within area
Sterna dougallii Roseate Tern [817]		Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Thalassarche cauta Tasmanian Shy Albatross [89224]	Vulnerable*	Foraging, feeding or related behaviour 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*	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Breeding known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area

Name	Threatened	Type of Presence
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
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Aipysurus pooleorum Shark Bay Seasnake [66061]		Species or species habitat may occur within area
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
Disteira kingii Spectacled Seasnake [1123]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or

Name	Threatened	Type of Presence
		related behaviour known to occur within area
Pelamis platurus Yellow-bellied Seasnake [1091]		Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dophin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Alfred Cove	WA
Balannup Lake	WA
Beelu	WA
Ellen Brook	WA
Forrestdale Lake	WA
Gibbs Road	WA
Gooseberry Hill	WA
Greenmount	WA
Jandabup	WA

Name	State
John Forrest	WA
Kalamunda	WA
Keanes Point Reserve	WA
Kenwick Wetlands	WA
Korung	WA
Lake Joondalup	WA
Lesmurdie Falls	WA
Matilda Bay Reserve	WA
Milyu	WA
NTWA Bushland covenant (0074)	WA
NTWA Bushland covenant (0157)	WA
Neaves Road	WA
Neerabup	WA
Parkerville	WA
Paruna	WA
Piara	WA
Talbot Road	WA
Thomsons Lake	WA
Twin Swamps	WA
Unnamed WA21176	WA
Unnamed WA23076	WA
Unnamed WA24657	WA
Unnamed WA28740	WA
Unnamed WA29815	WA
Unnamed WA31906	WA
Unnamed WA37997	WA
Unnamed WA43290	WA
Unnamed WA44414	WA
Unnamed WA44853	WA
Unnamed WA45106	WA
Unnamed WA45772	WA
Unnamed WA45773	WA
Unnamed WA46756	WA
Unnamed WA46875	WA
Unnamed WA46919	WA
Unnamed WA46920	WA
Unnamed WA46926	WA
Unnamed WA47244	WA
Unnamed WA49079	WA
Unnamed WA49220	WA
Unnamed WA49299	WA
Unnamed WA49300	WA
Unnamed WA49362	WA
Unnamed WA49363	WA
Unnamed WA49561	WA
Unnamed WA50067	WA
Unnamed WA50069	WA
Unnamed WA50514	WA
Walyunga	WA
Woodvale	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

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

Name	Status	Type of Presence
		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
Capra hircus Goat [2]		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
Feral deer Feral deer species in Australia [85733]		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 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

Name	Status	Type of Presence
		habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		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, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
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
Solanum elaeagnifolium Silver Nightshade, Silver-leaved Nightshade, White Horse Nettle, Silver-leaf Nightshade, Tomato Weed, White Nightshade, Bull-nettle, Prairie-berry, Satansbos, Silver-leaf Bitter-apple, Silverleaf-nettle, Trompillo [12323]		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
Brixton Street Swamps	WA
Ellen Brook Swamps System	WA
Gibbs Road Swamp System	WA
Herdsman Lake	WA
Joondalup Lake	WA
Palmer Barracks, Guildford	WA
Perth Airport Woodland Swamps	WA
RAAF Caversham	WA
Swan-Canning Estuary	WA
Thomsons Lake	WA

Key Ecological Features (Marine) [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Commonwealth marine environment within and	South-west
Western rock lobster	South-west

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

-31.89266 115.91801

Acknowledgements

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-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
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-Geoscience Australia
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-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
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-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
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-Other groups and individuals

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

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