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.

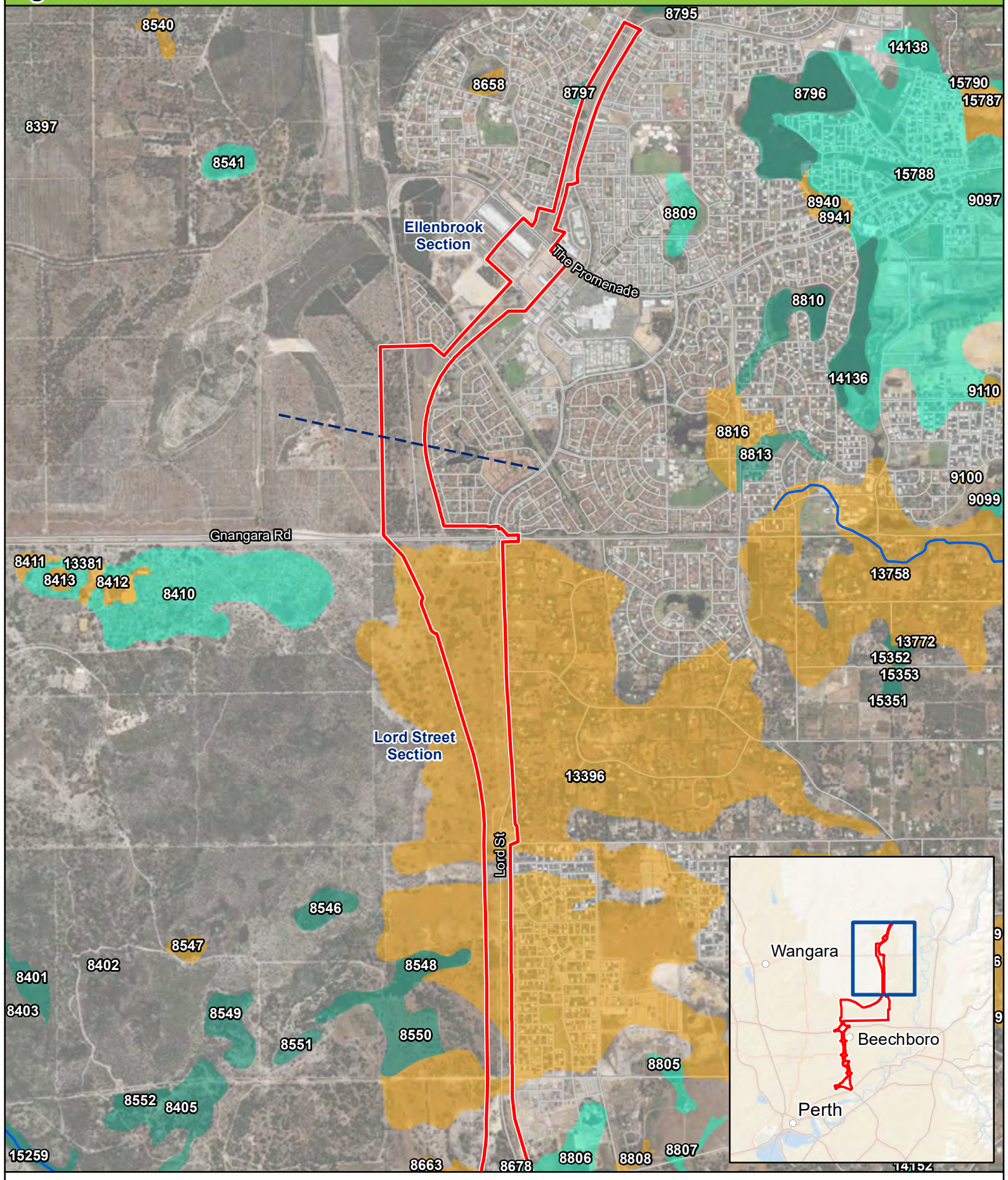
Monitoring of water and sediment quality was conducted annually in Bennett Brook from 2003 over a period of at least 12 years approximately 1.5 km south (downstream) of its intersection with the ERB.

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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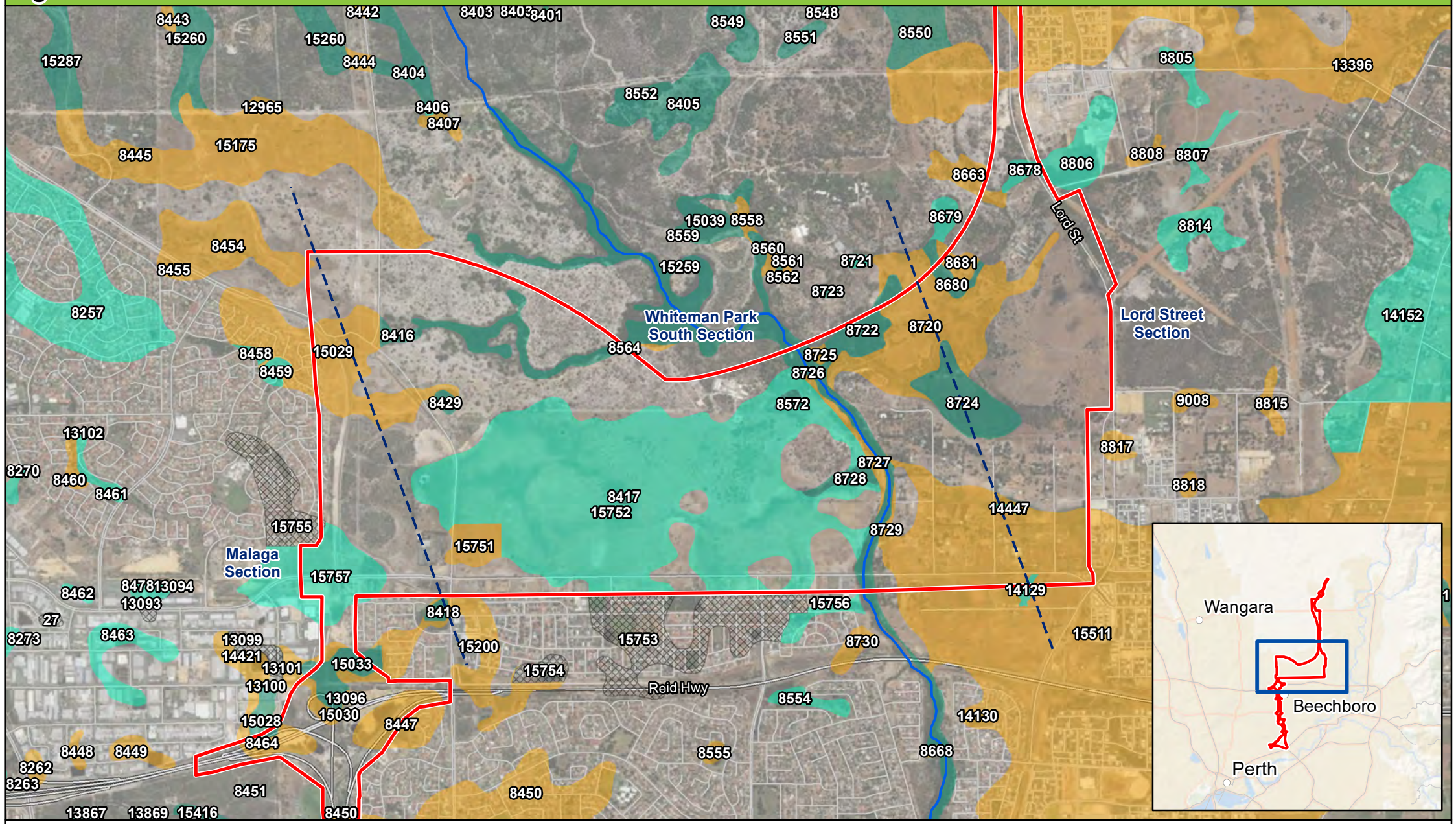
Prepared by: SM Date: 19/03/2019

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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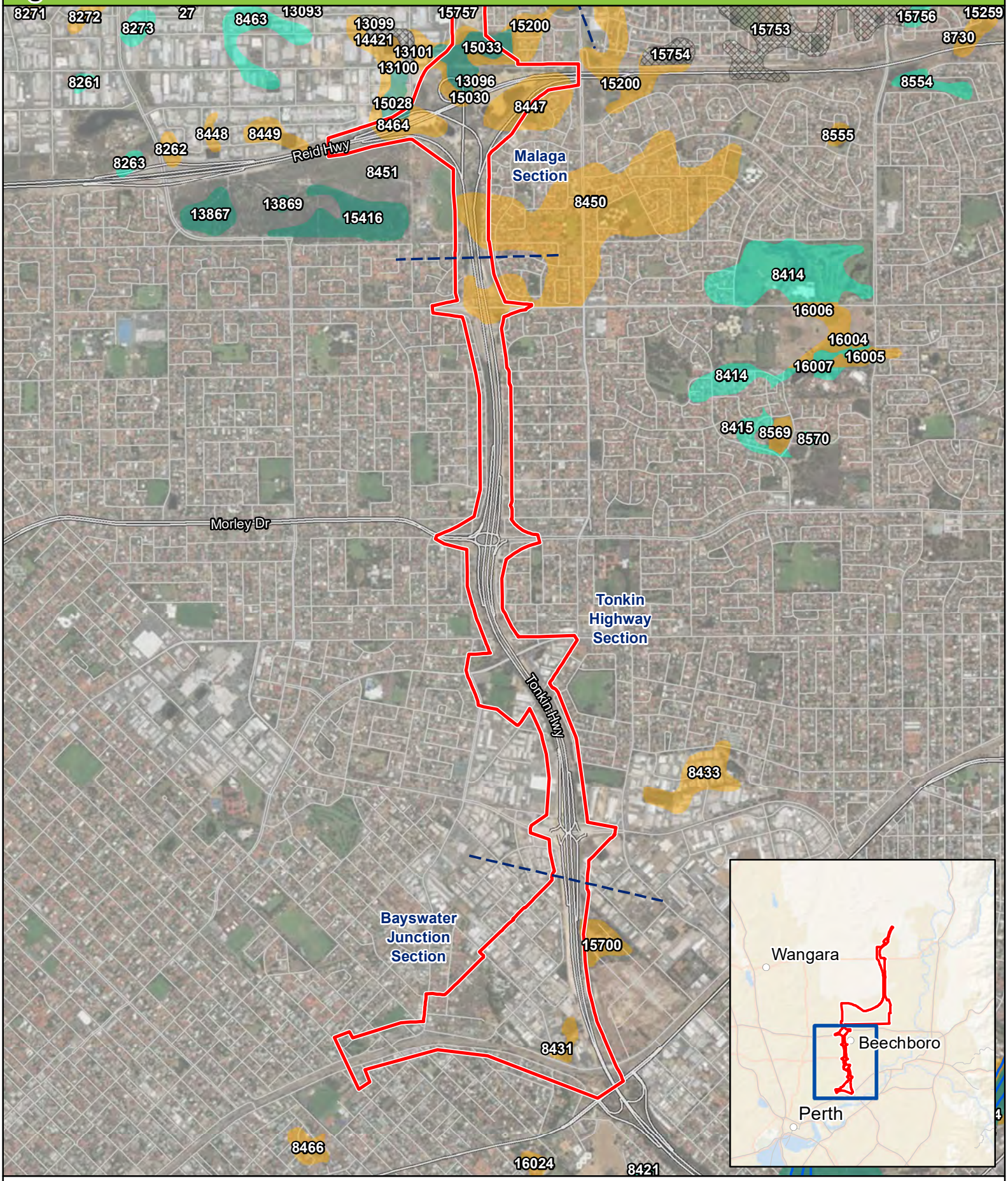
Prepared by: SM Date: 19/03/2019

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.

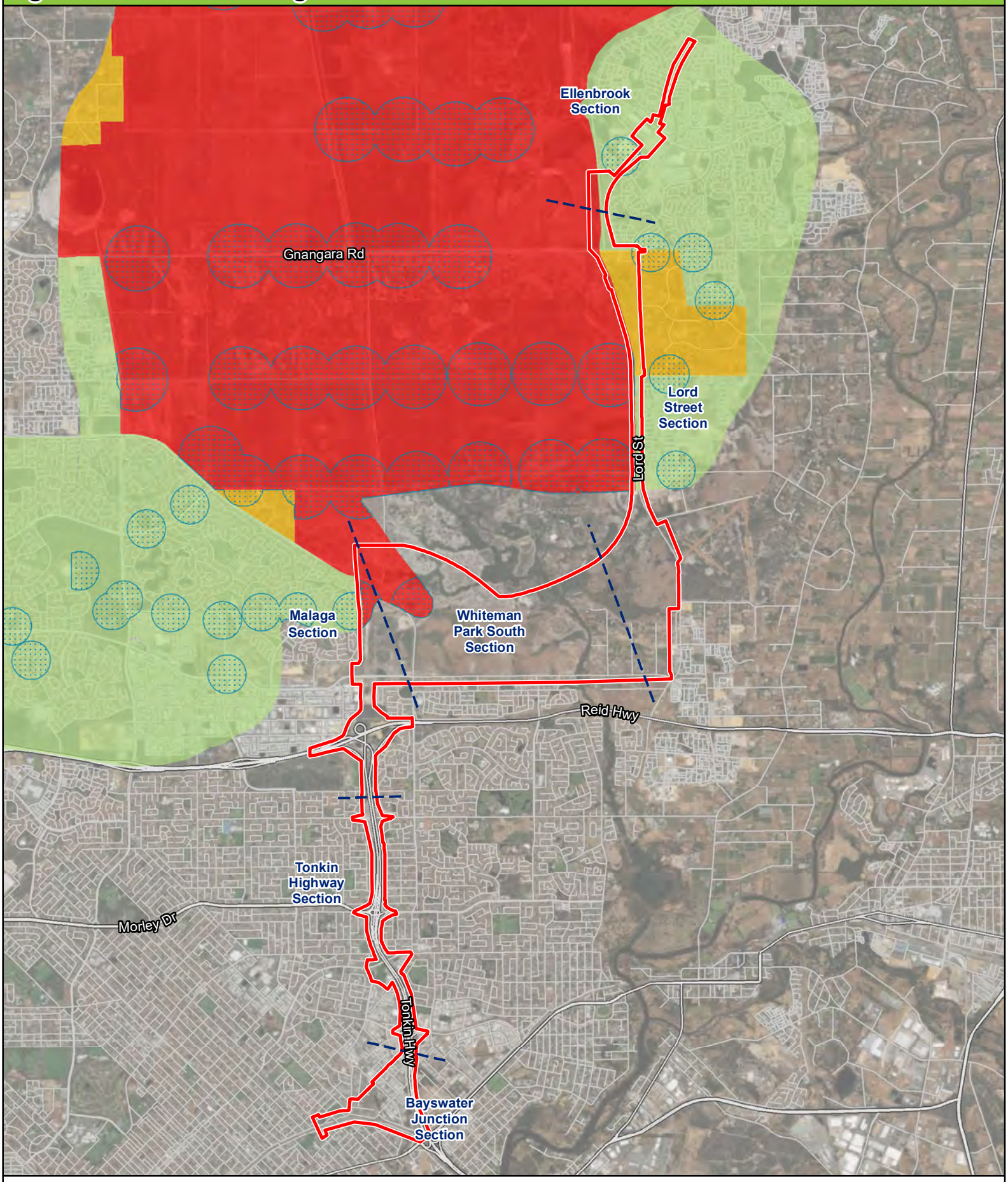
4.3.3.4 PDWSAs

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*.

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).

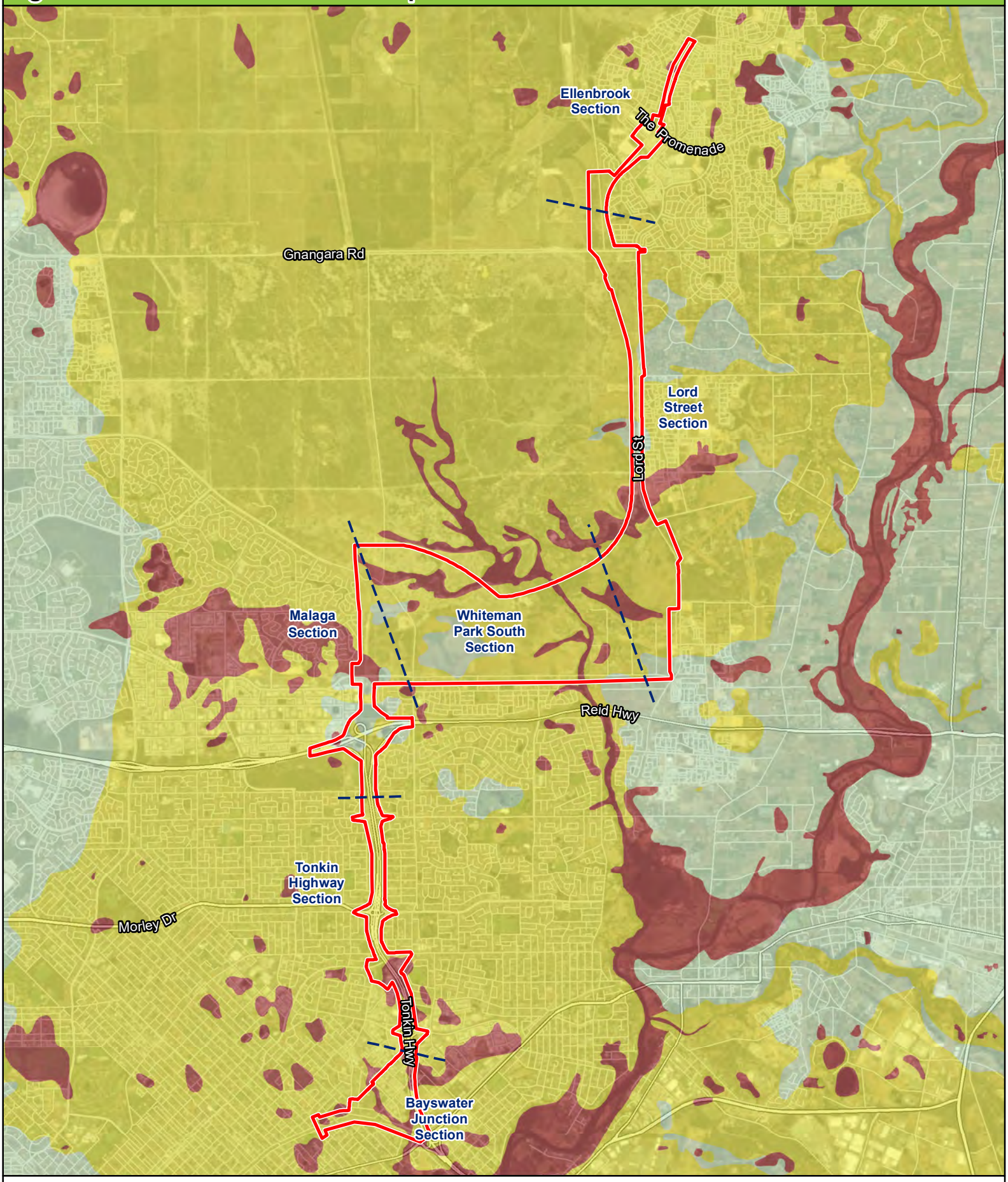
Within the northern half of the ERB, areas where there is a *high probability* of occurrence are generally limited to small low lying areas (Jacobs 2018). Isolated peaty deposits associated with humic wetlands

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

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Prepared by: SM Date: 22/03/2019

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:

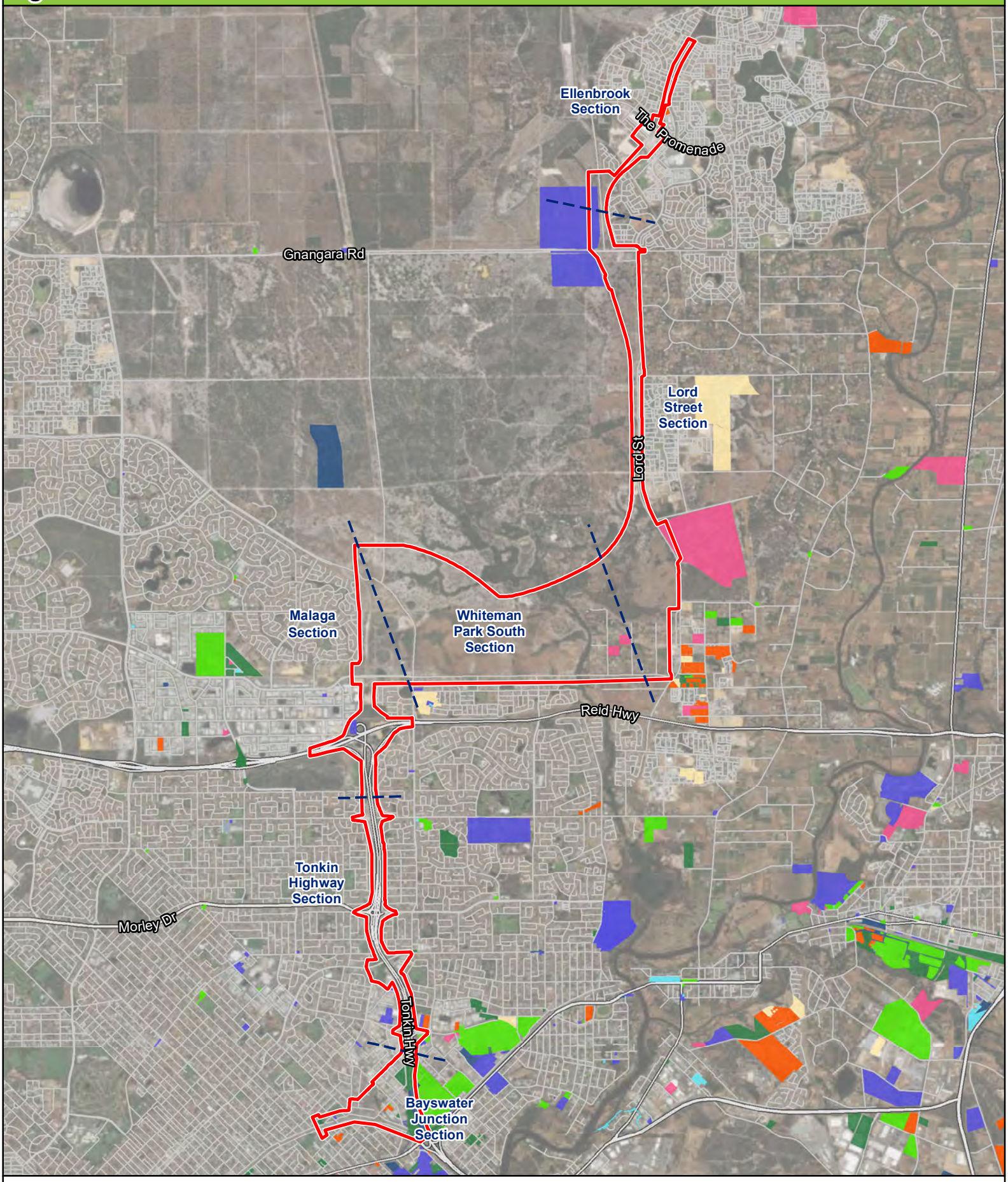
- Contaminated – restricted use (C-RU);
- Remediated for restricted use (RRU); or
- Contaminated – remediation required (CRR).

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.

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):

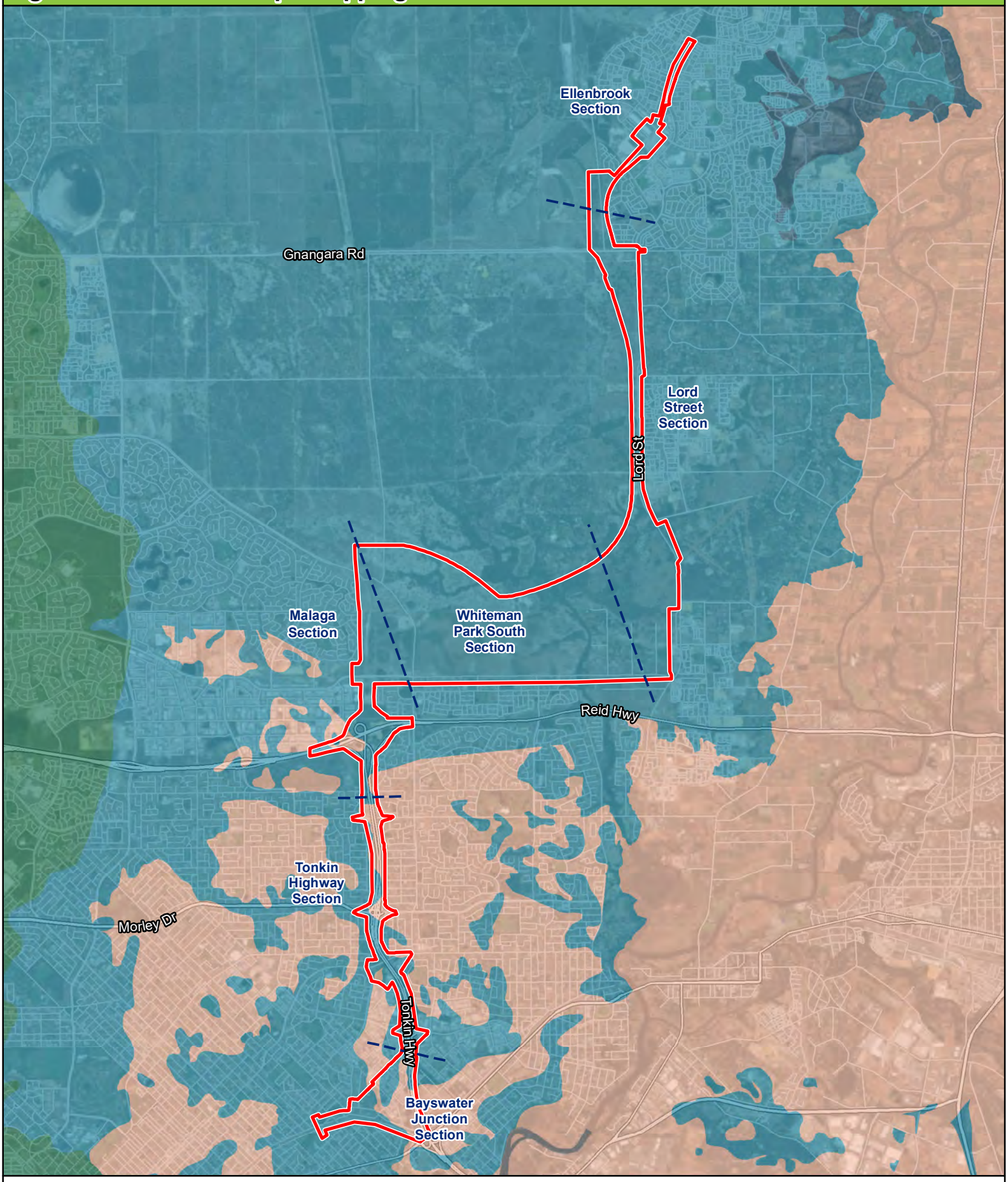
- The hyporheic zone (the area beneath and alongside the stream where there is mixing of shallow groundwater and surface water) surrounding Bennett Brook.
- Mound springs (discussed in Chapter 2).
- Porous zones within the alluvial Guildford formation underlying the Bassendean sands in parts of the ERB (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

ecological AUSTRALIA
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.

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).

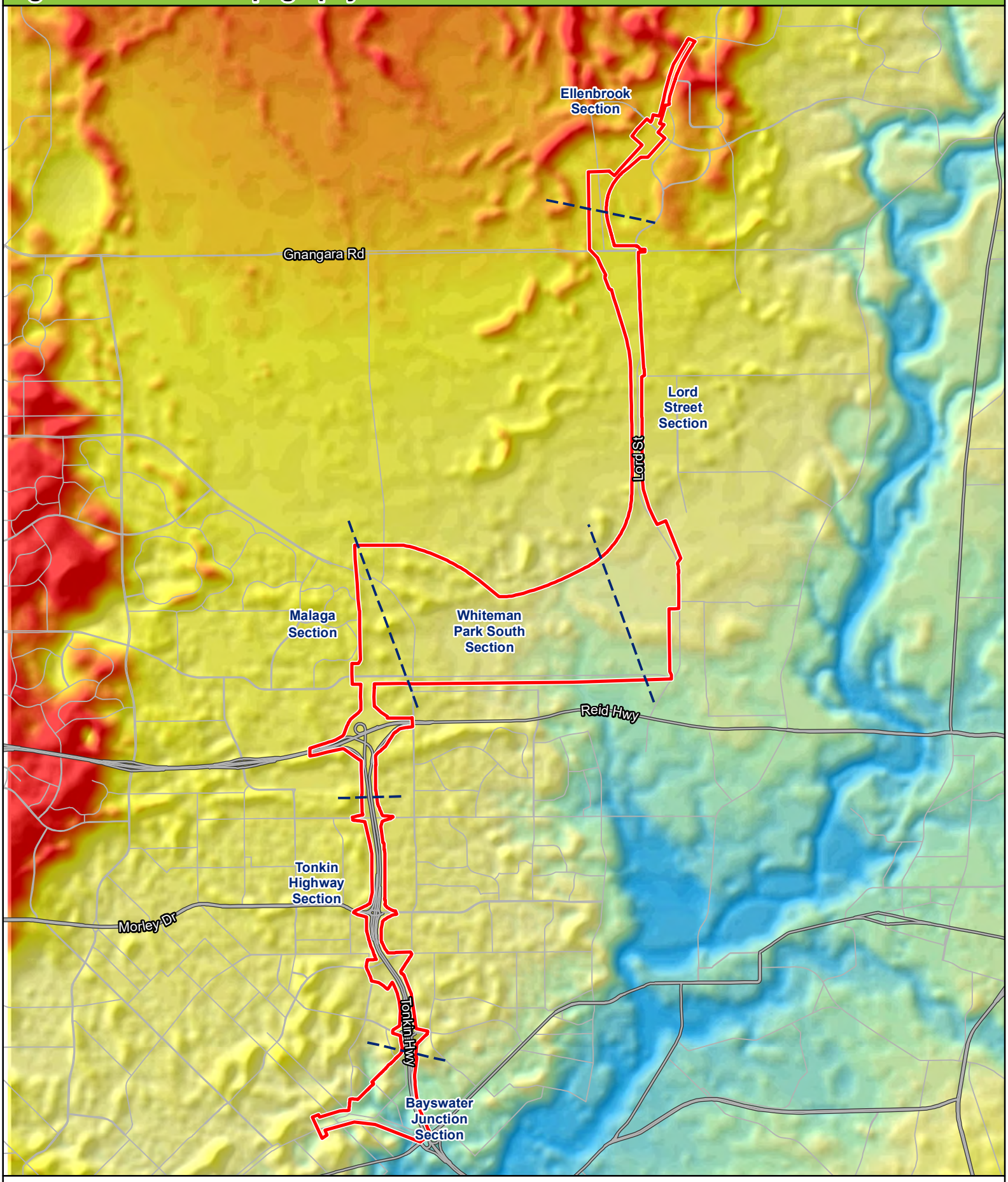
The ERB is located within the Bassendean dune system (Figure 8-1), an extensive system of shoreline deposits and coastal dunes running north-south and covering a 15 km wide zone of Perth Swan Coastal Plain (Gozzard 2007). The Bassendean dune system is relatively featureless in terms of topography, comprising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

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).

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.

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Appendix A : Desktop fauna search

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

Australian Government
Department of the Environment and Energy

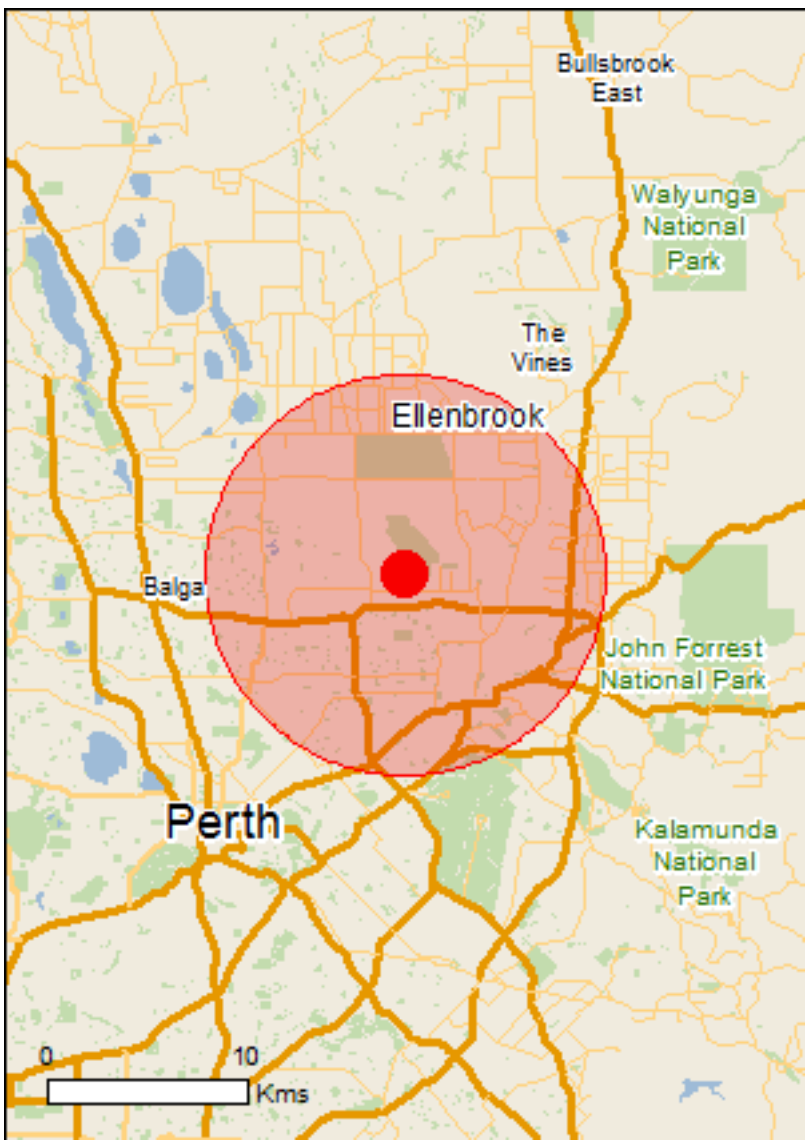
EPBC Act Protected Matters Report

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



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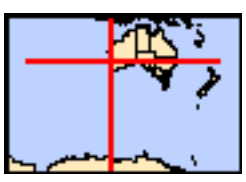

Summary

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:	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: Bayswater to Malaga Rail Works - Vegetation and Black Cockatoo Habitat Assessment

Memorandum

11 November 2019

To	Public Transport Authority		
Copy to			
From	GHD Pty Ltd		
Subject	Morley-Ellenbrook Line Stage 1 – Vegetation and Black Cockatoo Habitat Assessment for the provided survey area	Job no.	6138451-04

1 Introduction

1.1 Background

The Public Transport Authority (PTA) is progressing Stage 1 of the Morley-Ellenbrook Line (MEL) Project (the project). A number of biological surveys have been completed over the project area, however gaps have been identified where vegetation type and condition, and black cockatoo habitat assessments have not occurred.

1.2 Scope of works and purpose

The PTA commissioned GHD Pty Ltd (GHD) to complete a vegetation and black cockatoo habitat assessment for the provided survey area. The purpose of the commission was to describe and map the vegetation types and condition, and undertake a black cockatoo habitat assessment for the survey area, to support environmental assessment and approval process.

The survey area covers 74.55 hectares (ha). The findings of the survey are provided in this brief memorandum.

1.3 Limitations and assumptions

This memorandum has been prepared by GHD for PTA and may only be used and relied on PTA for the purpose agreed between GHD and the PTA as set out in section 1.2 of this memorandum. GHD otherwise disclaims responsibility to any person other than PTA arising in connection with this memorandum. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this memorandum were limited to those specifically detailed in the memorandum and PTA request correspondence.

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

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2 Methodology

2.1 Desktop assessment

Prior to the field survey, a desktop assessment was undertaken to identify relevant information pertaining to the survey area. The desktop assessment included a review of:

- Previous surveys and mapping provided by PTA that covered the project area
- Aerial imagery of the survey area.

2.2 Field survey

2.2.1 Vegetation

GHD botanist Joel Collins completed a rapid vegetation assessment of the survey area on 30 and 31 October 2019. The field survey was undertaken to verify the information obtained from the desktop assessment and assess and characterise the broad vegetation types and vegetation condition throughout the survey area. Preliminary assessment of occurrence and approximate extent of potential Threatened and Priority Ecological Communities (TECs and PECs) was also completed.

Field survey method involved traversing the survey area on foot and sampling using photo points.

Broad vegetation types

Broad vegetation types were identified and boundaries delineated using a combination of aerial photography, topographical features and field data/observations. Full floristics were not recorded.

The vegetation types were described based on structure, dominant taxa and cover characteristics. The broad vegetation type description is consistent with National Vegetation Information System (NVIS) Level IV or V, where the dominant species for the three traditional strata (upper, mid and ground) are used to describe the association (NVIS Technical Working Group 2017).

Vegetation condition

The vegetation condition was assessed and mapped in accordance with the vegetation condition rating scale for the South West and Interzone Botanical Provinces of WA (devised by Keighery (1994) and adapted by EPA (2016)).

2.2.2 Black cockatoos

The black cockatoo habitat assessment was undertaken in conjunction with the vegetation assessment. The assessment involved visual and aural assessment of the survey area identifying breeding habitat (presence/absence of actual and potential breeding trees), foraging habitat, roosting areas, current activity and any other signs of use by *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) listed black cockatoos species: Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*Calyptorhynchus baudinii*), and Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*). For the purpose of this assessment, the Department of Sustainability, Environment, Water, Populations and Communities (DSEWPaC) (2012) black cockatoo referral guidelines were used to define habitat.

The targeted habitat assessment for black cockatoos included:

- The identification and recording (via GPS) of the locations of potential and actual breeding habitat within the survey area (relevant tree species with a diameter at breast height (DBH)
- Identifying, describing and recording the size of existing tree hollows and any evidence of use by black cockatoos within the survey area.

3 Results

3.1 Vegetation types and condition

Nine vegetation types were identified and described in the survey area as well as revegetation areas. Previously cleared areas, including the existing road network infrastructure, has been mapped as cleared. Details and a representative photograph of each of the vegetation types are provided in Table 1. The distribution of the vegetation types are presented in Figure 1.

Vegetation condition throughout the survey area ranged from Good to Completely Degraded (Figure 2). The vegetation has been subjected to previous clearing, edge effects, weeds and rubbish dumping which has resulted in reduced species diversity and composition.

Based on the rapid vegetation assessment none of the vegetation types represent occurrences of the *Banksia* Woodlands of the Swan Coastal Plain (TEC). There were no patches of *Banksia* woodland that meet the key diagnostic characteristics of condition and patch size thresholds (TSSC 2016). Vegetation types, VT02 (0.38 ha) and VT04 (0.37 ha) represent occurrences of the *Banksia* Dominated Woodlands of the Swan Coastal Plain IBRA Region (PEC). This PEC differs from the TEC in that it has no minimum condition or patch size thresholds.

3.2 Black cockatoo habitat assessment

Eighty eight (88) potential breeding habitat trees with DBH greater than 500 mm were recorded from the survey area. Four of these trees have nesting boxes installed, although one was being utilised by bees. No hollows suitable of black cockatoo use were observed from the ground based assessment. Feeding evidence was observed under one *Corymbia calophylla* tree. The habitat tree DBH and species name data is presented in Table 2 and Figure 3.

Black Cockatoo foraging habitat value for each vegetation type is presented in Figure 3.

Table 1 Vegetation types and condition

Vegetation types	Vegetation description	Condition and extent (ha)	Photograph
VT01	*Corymbia calophylla* open woodland over *Melaleuca preissiana* low open woodland over **Acacia longifolia* and **Acacia iteaphylla* open shrubland over *Xanthorrhoea preissii* open shrubland over mixed introduced grasses **Ehrharta calycina* and **Avena barbata*. Vegetation condition mapped as Degraded with high weed cover and limited understorey with edge effects and rubbish dumping.	Degraded (0.38 ha)	
VT02	*Banksia attenuata, Banksia menziesii* and *Nuytsia floribunda* low open woodland over *Adenanthos cygnorum* and *Allocasuarina humilis*, *Stirlingia latifolia* open shrubland over *Hibbertia hypericoides* low open shrubland over *Lyginia imberbis* and *Desmocladus flexuosus* with **Ehrharta calycina* and other introduced grasses. Vegetation condition mapped as Good to Degraded with high weed cover and reduced understorey with edge effects and rubbish dumping.	Good (0.13 ha) Degraded (0.06 ha)	

Vegetation types	Vegetation description	Condition and extent (ha)	Photograph
VT03	*Corymbia calophylla, Melaleuca preissiana* and *Agonis flexuosa* scattered mixed tress with mixed plantings of established *Eucalyptus* sp. (non-local species) trees over introduced mixed grasses. Vegetation condition mapped as Completely Degraded with highly modified structure and previous disturbance.	Degraded (0.03 ha) Completely degraded (0.59 ha)	
VT04	*Eucalyptus todtiana, Corymbia calophylla Allocasuarina fraseriana* and *Banksia menziesii* low open woodland over planted **Leptospermum laevigatum* and *Callistemon phoeniceus* shrubs over **Ehrharta calycina* and other introduced grasses. Vegetation condition mapped as Degraded to Completely Degraded with high weed cover and reduced understorey with edge effects and rubbish dumping.	Degraded (0.07 ha) Completely Degraded (0.31 ha)	

Vegetation types	Vegetation description	Condition and extent (ha)	Photograph
VT05	*Melaleuca preissiana* open woodland over *Hakea varia* and *Acacia saligna* over *Xanthorrhoea preissii* and *Regelia ciliata* open shrubland over introduced grasses. Vegetation condition mapped as Good to Completely Degraded with high weed cover and reduced understorey with edge effects.	Good (0.12 ha) Completely degraded (0.12 ha)	
VT06	*Corymbia calophylla* open woodland over *Allocasuarina humilis* and *Xanthorrhoea preissii* open shrubland over *Dasypogon bromeliifolius* over introduced grasses **Ehrharta calycina* and **Avena barbata*. Vegetation condition mapped as Degraded with high weed cover and limited understorey with edge effects.	Degraded (0.24 ha) Completely degraded (0.21 ha)	

Vegetation types	Vegetation description	Condition and extent (ha)	Photograph
VT07	*Baumea articulata* sedgeland in artificial drainage sump. Vegetation condition mapped as Completely Degraded with highly modified structure and previous disturbance.	Completely Degraded (0.25 ha)	
VT08	*Corymbia calophylla* and *Eucalyptus gomphocephala* trees over maintained introduced grasses. Some areas include planted non-local *Eucalyptus* sp. in parklands. Vegetation condition mapped as Completely Degraded with highly modified structure and previous disturbance.	Completely Degraded (1.63 ha)	

Vegetation types	Vegetation description	Condition and extent (ha)	Photograph
VT09	Highly disturbed mixed scattered trees of *Melaleuca preissiana* and planted **Eucalyptus* sp and **Eucalyptus camaldulensis* over *Hakea varia,* **Acacia longifolia* and **Acacia iteaphylla* open shrubland over introduced grasses **Ehrharta calycina* and **Avena barbata*. Other native species include *Adenanthos cygnorum* and *Stirlingia latifolia.* Vegetation condition mapped as Completely Degraded with highly modified structure and previous disturbance.	Completely Degraded (0.77 ha)	
Revegetation	Revegetated areas from recent plantings to established revegetation (historical planting) containing non-local species **Leptospermum laevigatum* and **Chamelaucium uncinatum*	Revegetation (14.78 ha)	

Vegetation types	Vegetation description	Condition and extent (ha)	Photograph
			

Table 2 Black Cockatoo habitat assessment data

Species	DBH (mm)	Comment	Latitude	Longitude
Corymbia calophylla	740		115.9167	-31.8725
Corymbia calophylla	600	Dead stag. Multiple small hollows	115.9167	-31.8725
Corymbia calophylla	1100		115.9168	-31.8727
Corymbia calophylla	1300		115.9168	-31.8727
Corymbia calophylla	1000	Multiple small hollows	115.9169	-31.8727
Corymbia calophylla	1100		115.9169	-31.8728
Corymbia calophylla	600		115.9169	-31.8729
Corymbia calophylla	500		115.917	-31.873
Corymbia calophylla	750		115.9169	-31.873
Corymbia calophylla	1100	One small hollow	115.9169	-31.8731
Corymbia calophylla	600		115.9168	-31.8732
Corymbia calophylla	750		115.9168	-31.8732
Corymbia calophylla	750		115.9168	-31.8732
Corymbia calophylla	500		115.9168	-31.8732
Corymbia calophylla	600		115.9169	-31.8732
Corymbia calophylla	500		115.9168	-31.8743
Corymbia calophylla	800		115.9193	-31.8759
Corymbia calophylla	600	Nesting box installed with bees	115.9193	-31.876
Corymbia calophylla	600	Nesting box installed no bees	115.9192	-31.8759
Corymbia calophylla	500		115.9191	-31.876

Species	DBH (mm)	Comment	Latitude	Longitude
Corymbia calophylla	800		115.9191	-31.8759
Corymbia calophylla	600		115.919	-31.876
Corymbia calophylla	700		115.9188	-31.876
Corymbia calophylla	600		115.919	-31.8761
Corymbia calophylla	500		115.919	-31.8761
Corymbia calophylla	600		115.9193	-31.8764
Corymbia calophylla	700		115.9191	-31.8768
Corymbia calophylla	700		115.9191	-31.8768
Corymbia calophylla	800		115.9191	-31.8771
Corymbia calophylla	500		115.9193	-31.8958
Corymbia calophylla	500		115.9188	-31.896
Corymbia calophylla	800		115.9193	-31.8965
Corymbia calophylla	600		115.9193	-31.8965
Corymbia calophylla	700	Feeding evidence observed	115.9193	-31.8966
Corymbia calophylla	600		115.9193	-31.8968
Corymbia calophylla	700	Nesting box installed	115.9196	-31.8963
Corymbia calophylla	650		115.9176	-31.8975
Corymbia calophylla	700		115.919	-31.9182
Corymbia calophylla	700		115.9186	-31.9181
Corymbia calophylla	600		115.9184	-31.9182
Corymbia calophylla	600		115.9181	-31.9181
Corymbia calophylla	600		115.918	-31.9181

Species	DBH (mm)	Comment	Latitude	Longitude
Corymbia calophylla	1000		115.9183	-31.9179
Corymbia calophylla	600		115.9183	-31.9179
Corymbia calophylla	700		115.9186	-31.9179
Eucalyptus camaldulensis	500		115.9182	-31.8559
Eucalyptus camaldulensis	500		115.9184	-31.8559
Eucalyptus camaldulensis	600		115.9198	-31.8759
Eucalyptus camaldulensis	700		115.9193	-31.8761
Eucalyptus camaldulensis	800		115.9193	-31.8762
Eucalyptus camaldulensis	800		115.9182	-31.8961
Eucalyptus camaldulensis	600		115.9231	-31.9191
Eucalyptus camaldulensis	500		115.923	-31.9188
Eucalyptus camaldulensis	600		115.923	-31.9121
Eucalyptus camaldulensis	600		115.923	-31.9122
Eucalyptus camaldulensis	700		115.923	-31.9117
Eucalyptus camaldulensis	500		115.923	-31.9114
Eucalyptus camaldulensis	500		115.9229	-31.9111
Eucalyptus camaldulensis	500		115.9229	-31.9109
Eucalyptus camaldulensis	500		115.9229	-31.9108
Eucalyptus camaldulensis	500		115.9229	-31.9112
Eucalyptus camaldulensis	500		115.9231	-31.9131
Eucalyptus camaldulensis	500		115.9231	-31.9134
Eucalyptus camaldulensis	550		115.9229	-31.9098

Species	DBH (mm)	Comment	Latitude	Longitude
Eucalyptus camaldulensis	550		115.9229	-31.9102
Eucalyptus camaldulensis	550		115.9227	-31.9088
Eucalyptus camaldulensis	550		115.9227	-31.9089
Eucalyptus camaldulensis	500		115.9215	-31.9187
Eucalyptus gomphocephala	1200	Nesting box installed	115.9172	-31.8764
Eucalyptus gomphocephala	1300		115.9188	-31.918
Eucalyptus gomphocephala	500		115.9187	-31.918
Eucalyptus gomphocephala	700		115.9187	-31.918
Eucalyptus gomphocephala	1000		115.9187	-31.918
Eucalyptus gomphocephala	1000		115.9186	-31.918
Eucalyptus gomphocephala	500		115.9187	-31.918
Eucalyptus gomphocephala	500		115.9187	-31.9182
Other	550		115.9192	-31.8761
Other	600		115.9191	-31.8763
Other	500		115.919	-31.8774
Other	500		115.919	-31.8774
Other	700		115.919	-31.8775
Other	500		115.9183	-31.8959
Other	1000		115.918	-31.8959
Other	750		115.9178	-31.8959
Other	1300		115.918	-31.8961
Other	500		115.9211	-31.8951

Species	DBH (mm)	Comment	Latitude	Longitude
Other	550		115.921	-31.8951
Other	600		115.9214	-31.8954

4 References

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

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Keighery, BJ 1994, *Bushland Plant Survey: A Guide to Plant Community Survey for the Community*, Nedlands, Australia, Wildflower Society of Western Australia (Inc.).

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Threatened Species Scientific Community (TSSC) 2016, *Environmental Protection and Biodiversity Conservation Act 1999 Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain Ecological Community*, Department of the Environment and Energy, Canberra. Available at: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/131-conservation-advice.pdf.

Attachment A – Figures

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 50

PTA
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Vegetation Types

Project No. **61-38451-04**
Revision No. **A**
Date **6/11/2019**

FIGURE 1-1

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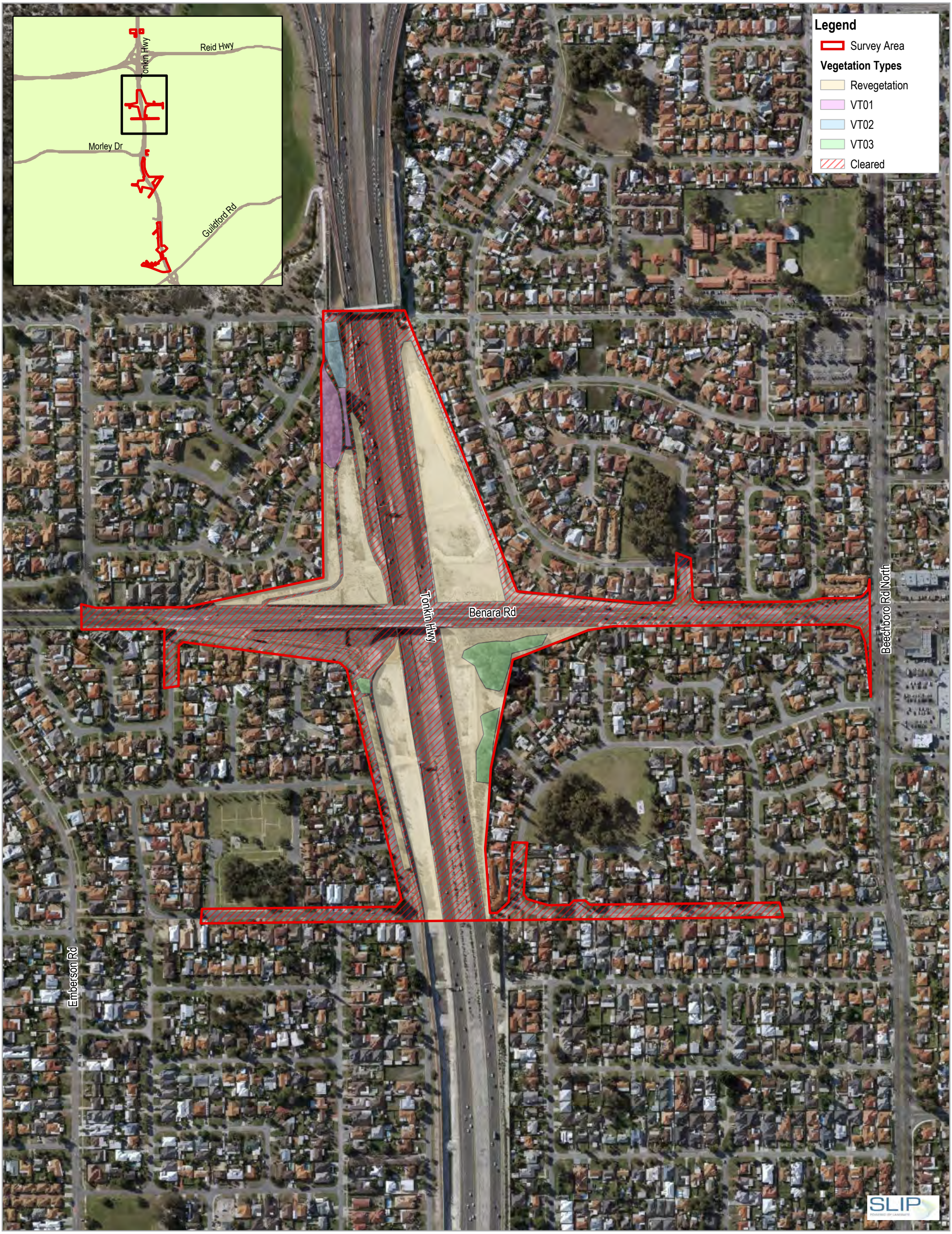

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Vegetation Types

Project No. **61-38451-04**
Revision No. **A**
Date **6/11/2019**

FIGURE1-2

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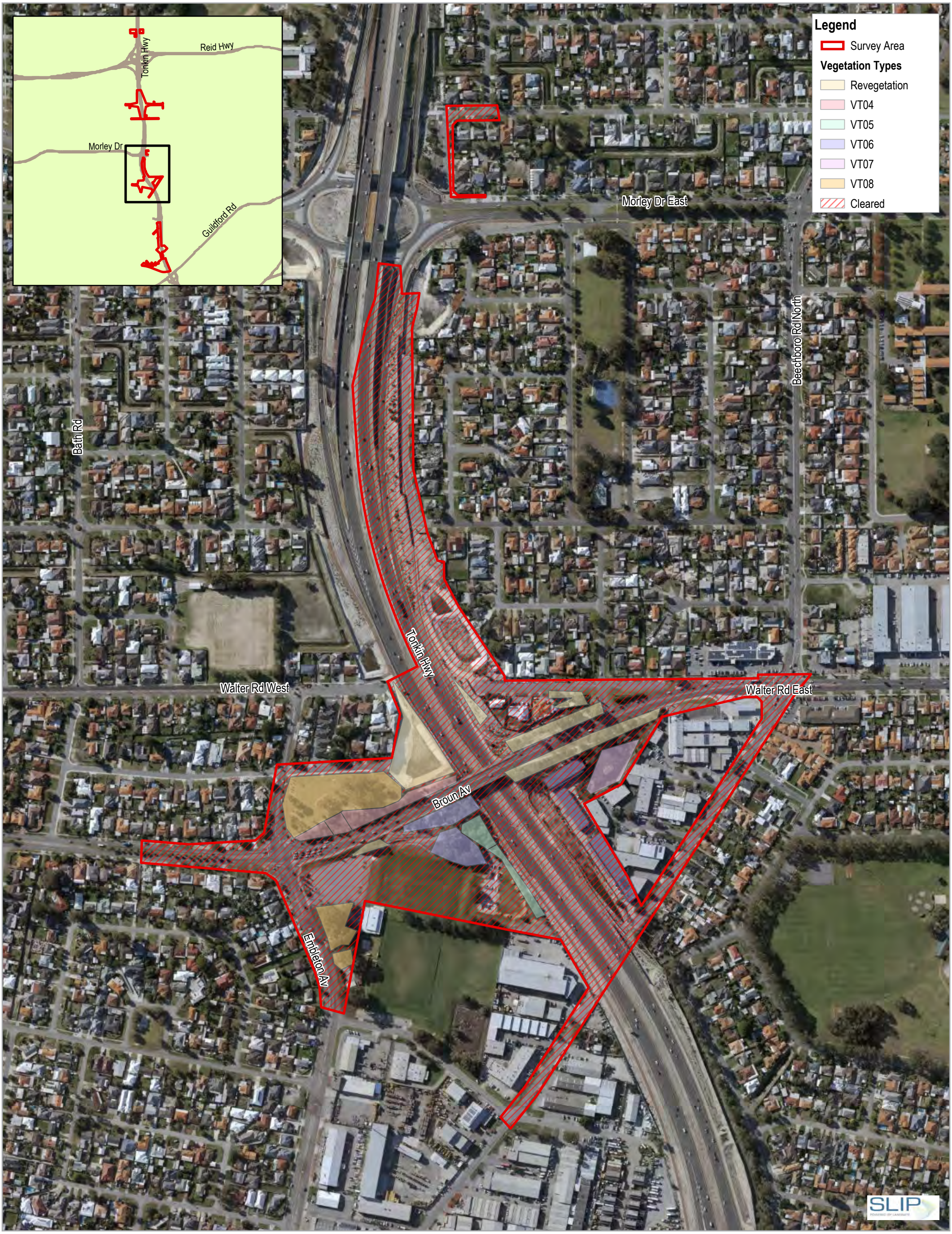

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Vegetation Types

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Date **6/11/2019**

FIGURE1-3

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Vegetation Types

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Date **6/11/2019**

FIGURE1-4

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Vegetation Types

Project No. **61-38451-04**
Revision No. **B**
Date **8/11/2019**

FIGURE 2-1

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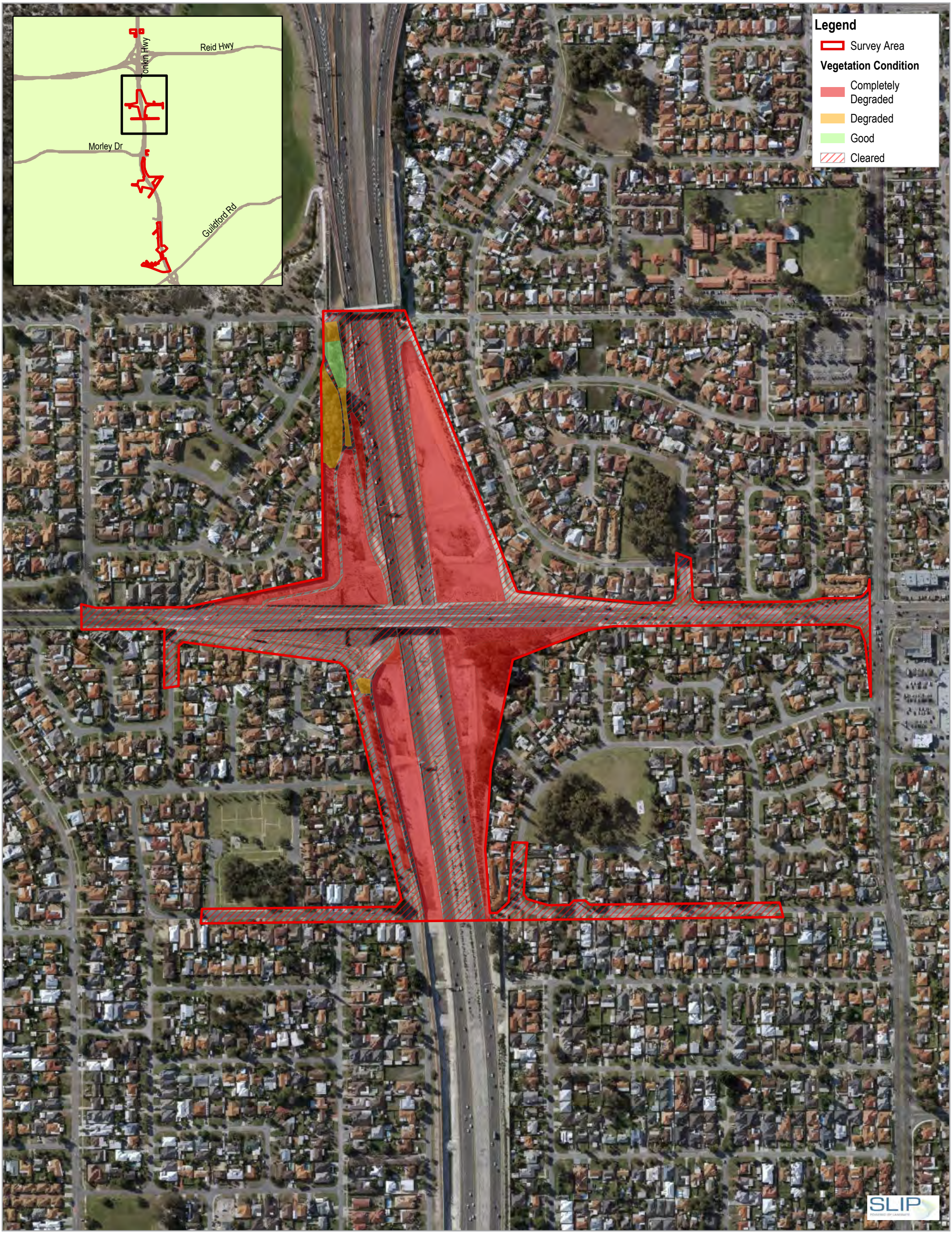

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Vegetation Types

Project No. **61-38451-04**
Revision No. **B**
Date **8/11/2019**

FIGURE 2-2

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Vegetation Types

Project No. **61-38451-04**
Revision No. **B**
Date **8/11/2019**

FIGURE 2-3

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Vegetation Types

Project No. **61-38451-04**
Revision No. **B**
Date **8/11/2019**

FIGURE 2-4

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Black Cockatoo Habitat Assessment

Project No. 61-38451-04
Revision No. B
Date 8/11/2019

FIGURE 3-1

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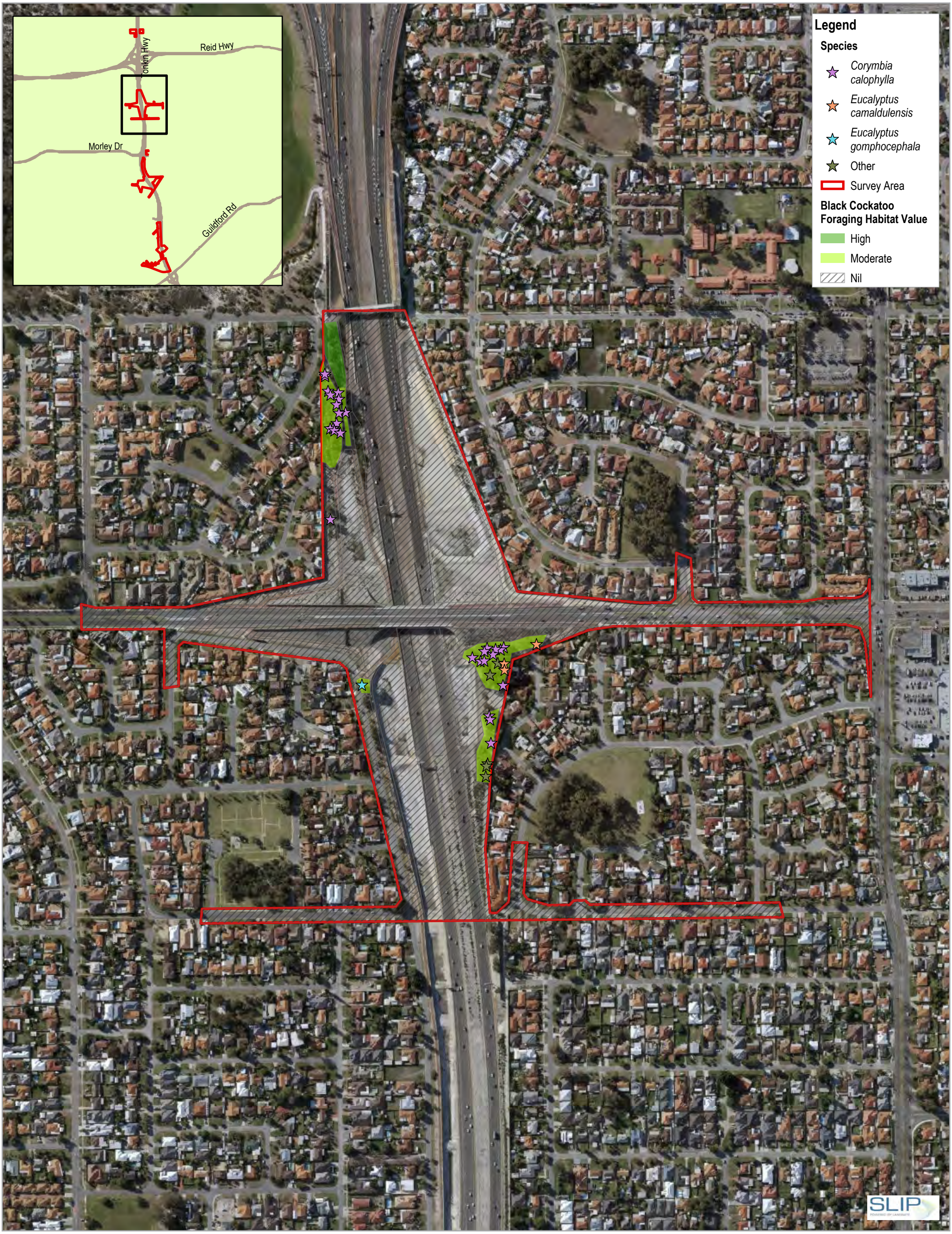

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Black Cockatoo Habitat Assessment

Project No. **61-38451-04**
Revision No. **B**
Date **8/11/2019**

FIGURE 3-2

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Black Cockatoo Habitat Assessment

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Date **8/11/2019**

FIGURE 3-3

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Black Cockatoo Habitat Assessment

Project No. **61-38451-04**
Revision No. **B**
Date **8/11/2019**

FIGURE 3-4

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