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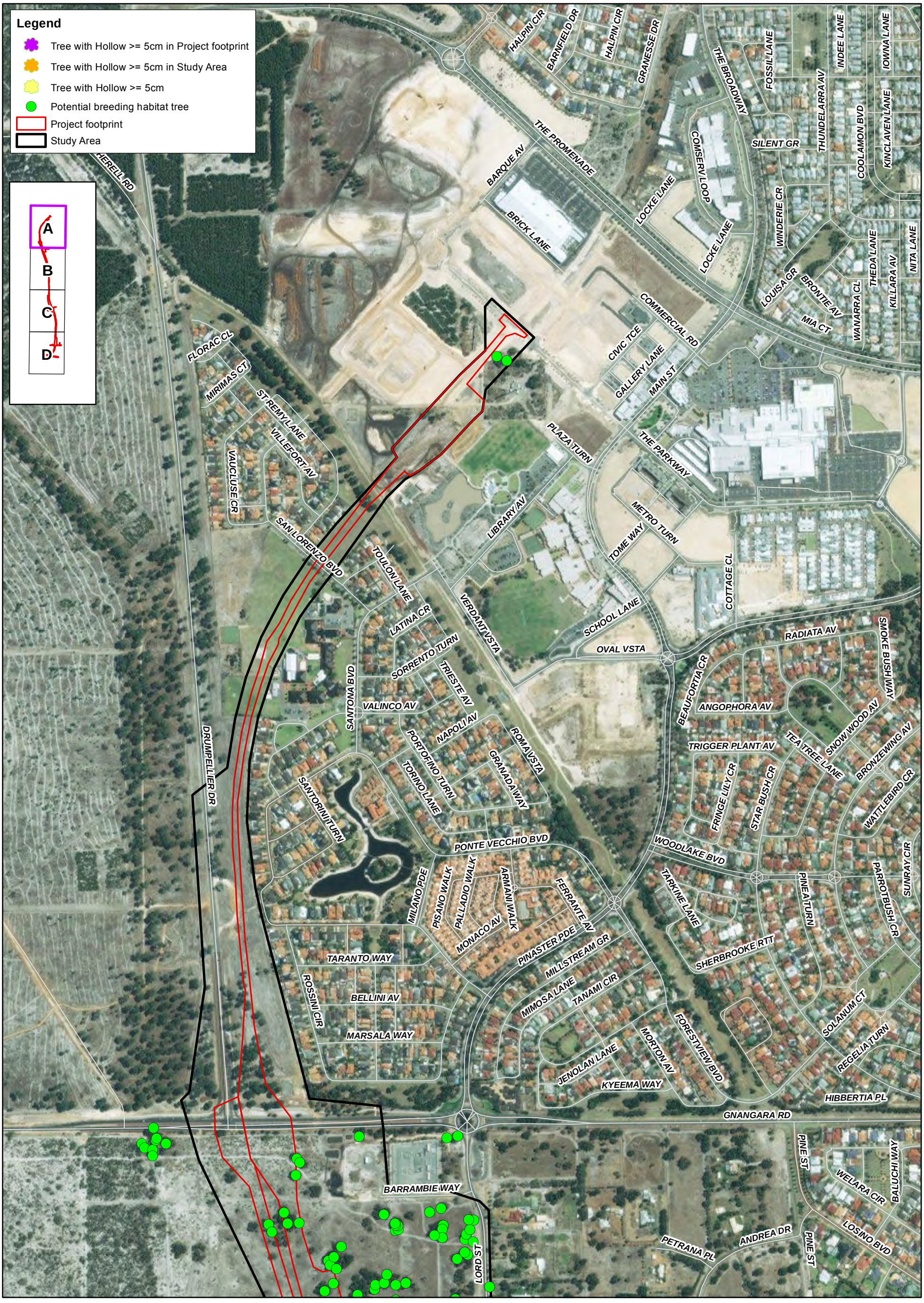

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Date: 13/06/2016 Version: 2 Job No: 247607

Coordinate System: GDA 1994 MGA Zone 50

MRWA Ellenbrook Bus Rapid Transit EIA and EMP

Figure 6A: Potential black cockatoo breeding trees

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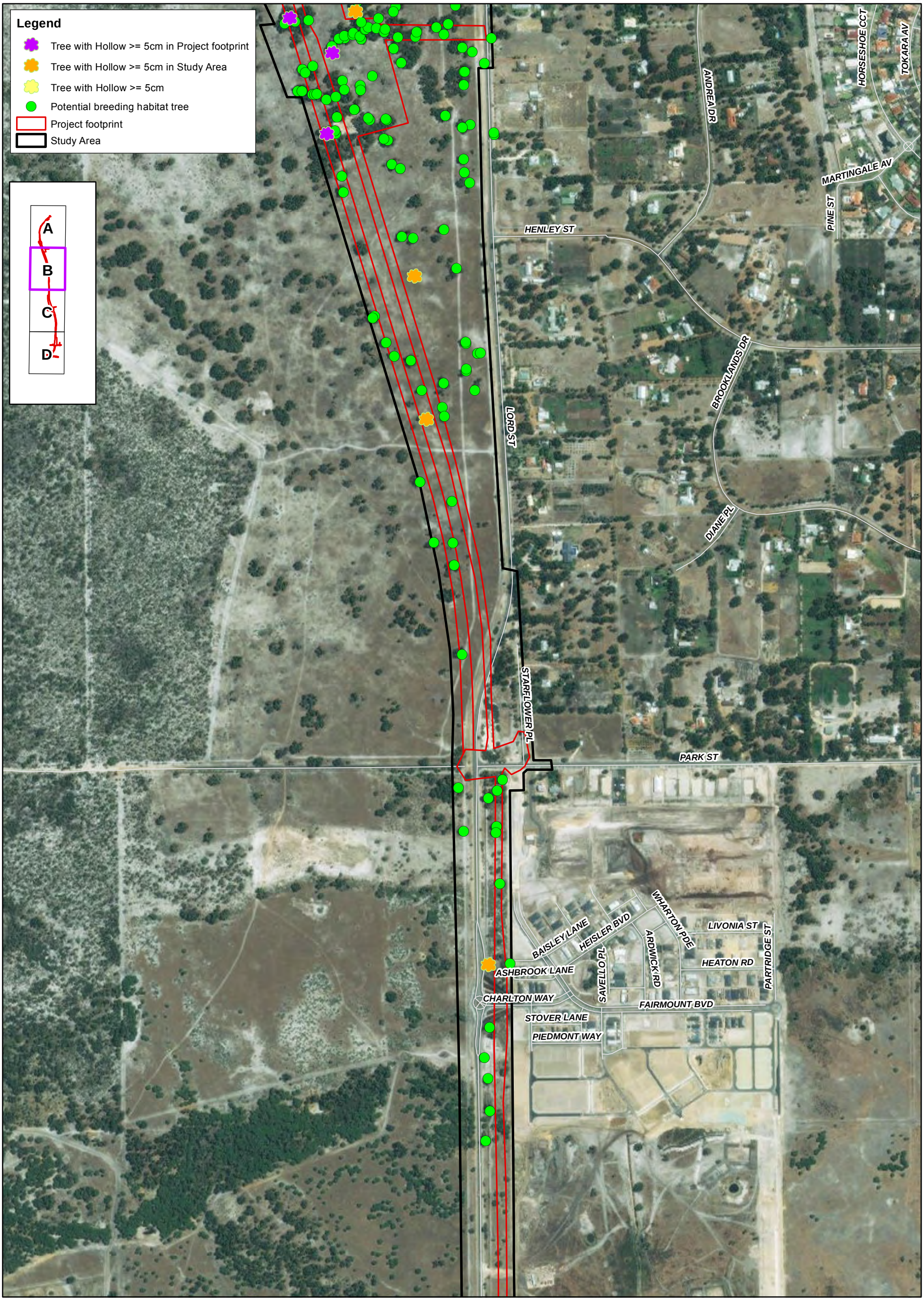

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Coordinate System: GDA 1994 MGA Zone 50

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Figure 6B: Potential black cockatoo breeding trees

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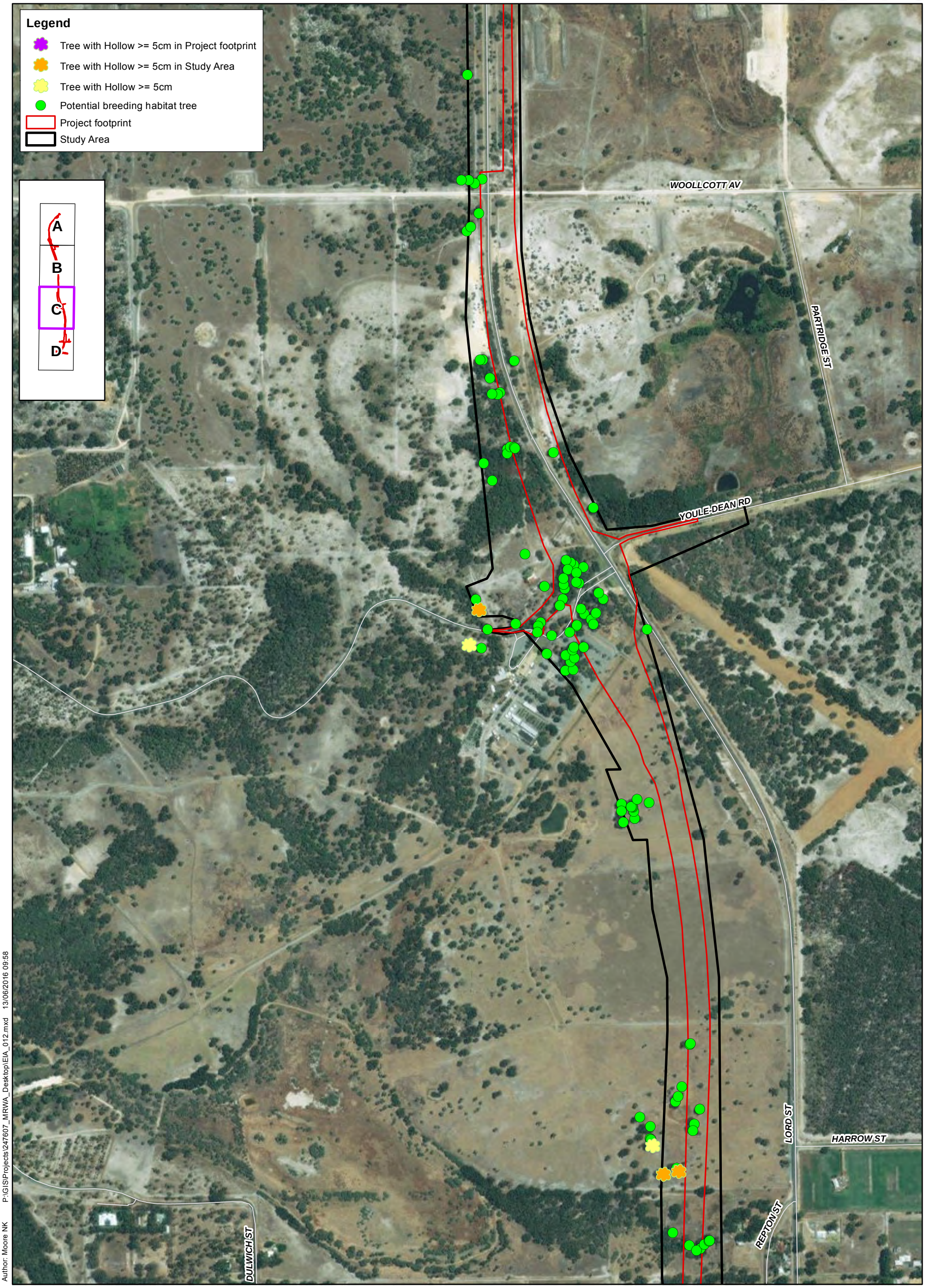

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Coordinate System: GDA 1994 MGA Zone 50

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Figure 6C: Potential black cockatoo breeding trees

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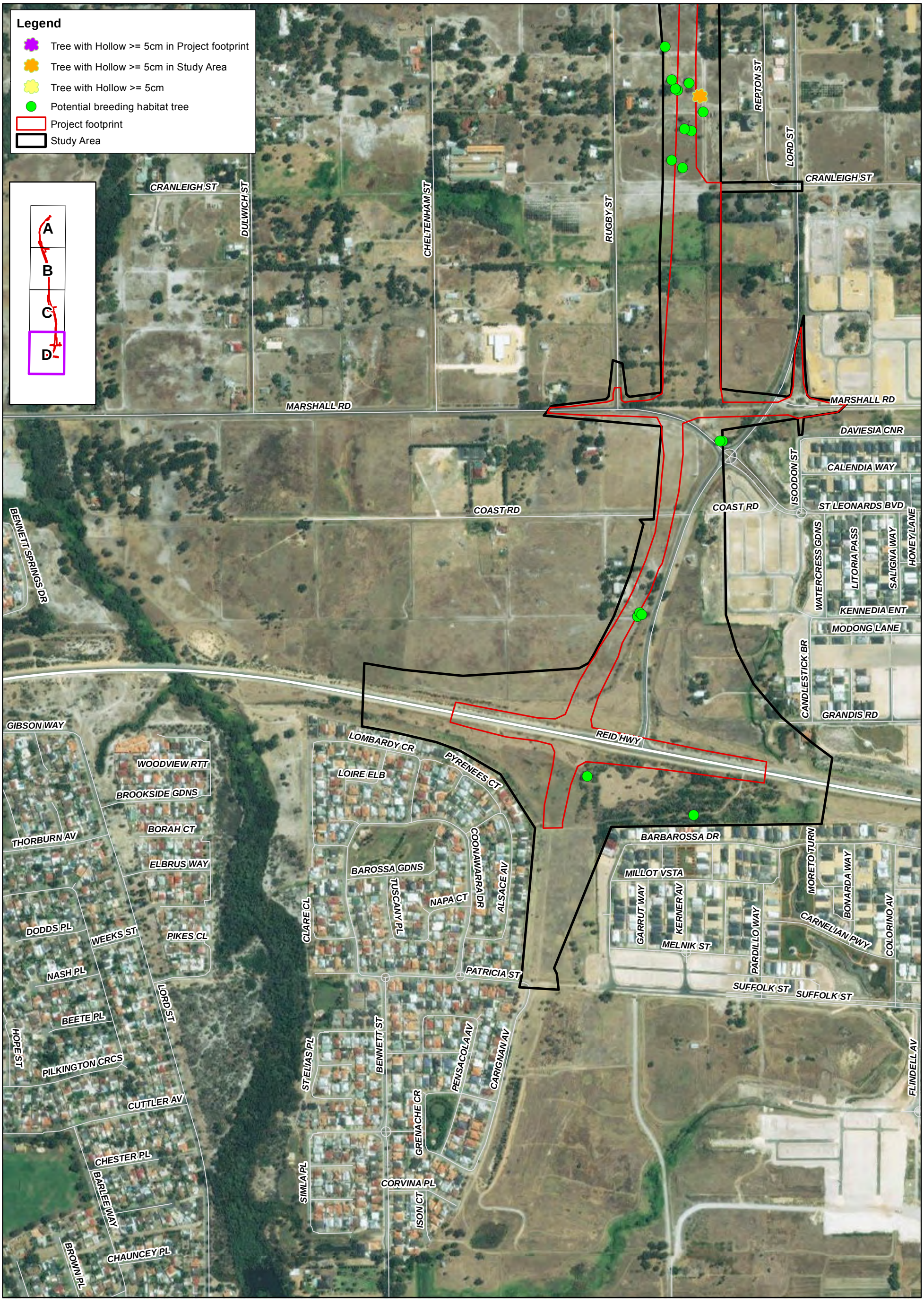

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Date: 13/06/2016 Version: 2 Job No: 247607

Coordinate System: GDA 1994 MGA Zone 50

MRWA Ellenbrook Bus Rapid Transit EIA and EMP

Figure 6D: Potential black cockatoo breeding trees

2.2.4.4 Assessment of potential impacts to terrestrial fauna

Clearing of 21.1ha of remnant native vegetation and 106 mature Eucalypt trees, for construction of the project will result in removal of suitable habitat for six conservation significant species. Table 12 below identifies predicted extent of habitat loss for each conservation significant species recorded or likely to occur within the project footprint. This is based on an assessment of habitat preferences for each species, and direct and indirect fauna observations recorded during the field survey (AECOM 2016).

Table 12 Predicted fauna use and loss of identified habitat types

	Fauna habitat type	Eucalypt/ Marri over grasses*	Melaleuca over introduced grasses	Melaleuca swampland	Melaleuca woodland	Pine plantation	Planted/ landscaping	Water	Total habitat loss (ha)
Species	Extent (ha)	10.0ha and 106 trees with DBH of 500mm or greater (5.4ha)	2.7	1.5	1.4	1.2	3.6	0.02	
	Forest Red-tailed Black Cockatoo	▲							10.0ha plus 106 trees
	Baudin's Black Cockatoo	▲				▲			11.2ha plus 106 trees
	Carnaby's Black Cockatoo	▲				▲			11.2ha plus 106 trees
	Rainbow Bee-eater	▲						▲	10.02ha
	Quenda	▲							10.0ha
	Western Brush Wallaby	▲	▲	▲	▲			▲	15.62ha

*Note that of the total 15.4ha of this habitat type, an area of 5.4ha contains 106 mature Eucalypt trees with DBH of 50mm or greater over cleared paddock with no understorey. These trees may be of habitat value to black cockatoos but are unlikely to be of value to ground dwelling species including Quenda and Western Brush Wallaby.

Carnaby's Black Cockatoo

Carnaby's Black Cockatoo occurs from Albany in the south to Kalbarri in the north (DSEWPaC 2011a) and in the semi-arid and sub-humid interior where it breeds in large hollows in tall, living or dead Eucalypts, most commonly in Wandoo and Salmon Gum. This species forages predominantly on proteaceous shrubs during the breeding season and also forages in Marri woodland. During the non-breeding season, Carnaby's Black Cockatoo will forage in pine plantation (DoE 2016a).

In addition, extensive suitable foraging habitat including Banksia woodlands is present in the Gnangara-Moore River State Forest (106ha) (Northlink 2015a) and Whiteman Park which contains Banksia woodlands (UBC 2016), both of which are within 5km of the project footprint. A study of Carnaby's Black Cockatoo foraging activity from Perth to Peel was conducted to identify foraging resources utilised by the species within this range. It reported evidence of Carnaby's Black Cockatoo foraging on Banksia species at Warbrook Road State Forest (EcoLogical Australia 2013).

Furthermore, Walyunga National Park, located approximately 9km north-east of the project footprint, east of the Darling Scarp, covers an area of 1790ha and supports open forest and woodland including Wandoo, a species preferentially utilised by Carnaby's Black Cockatoo for breeding, in addition to Marri and Jarrah (DEC 2014; DoE 2016d). A description of conservation areas in close proximity to the project footprint is provided in 2.3.9.2.

In contrast to the habitat available in these conservation reserves, the project footprint is considered unlikely to provide important habitat for Carnaby's Black Cockatoo. However Carnaby's Black Cockatoo is likely to occur within the project footprint given the availability of Banksia and Marri. A total of 106 Eucalypt trees, predominantly Marri, with DBH of 500mm or greater occur within the project footprint. Only three of these trees were observed to contain a hollow; however, at the time of survey, one of these hollows was occupied by bee. More of these trees may become valuable to Carnaby's Black Cockatoo in the future as they develop hollows large enough to accommodate this species; however, given the limited availability of breeding habitat, the project footprint is unlikely to support breeding of this species. The loss of 11.2ha of foraging habitat plus 106 mature Eucalypt trees, is therefore considered unlikely to significantly reduce local populations of Carnaby's Black Cockatoo.

Forest Red-tailed Black Cockatoo

The Forest Red-tailed Black Cockatoo feeds predominantly on Jarrah and Marri seeds, though will also utilise Blackbutt, Albany Blackbutt and some non-native species, including Cape Lilac. Understorey is usually not predictive of use by Forest Red-tailed Black Cockatoo (DoE 2016b). The loss of 10.0ha of suitable foraging habitat plus 106 Eucalypt trees, predominantly Marri, with DBH of 500mm or greater, including three trees containing a hollow is unlikely to reduce the species' range and is unlikely to significantly reduce local populations of this species given its preferred habitat is the dense Jarrah, Karri and Marri forests further south of the project footprint, which receive more than 600mm rainfall annually (DoE 2016b).

Suitable alternative habitat for Forest Red-tailed Black Cockatoo is present within Walyunga National Park where both Marri and Jarrah woodlands are present (DEC 2014; DoE 2016d). In addition, Whiteman Park immediately adjacent to the project footprint, comprises very mature Marri and Jarrah trees (UBC 2016) which provides suitable foraging and potential breeding habitat.

Baudin's Black Cockatoo

Baudin's Black Cockatoo is reliant on Marri for foraging. When Marri seed is not available, it will feed alternately on Jarrah, Banksia and varied introduced species including pine plantation, macadamia, pear and apple (DoE 2016c). Despite the presence of mature Marri trees within the project footprint, which provides foraging habitat for this species, the preferred habitat for Baudin's Black Cockatoo is the dense Jarrah, Karri and Marri forests in the far south-west of Western Australia, in areas with annual average rainfall of 750mm or above, where it breeds (DoE 2016c). In addition, Baudin's Black Cockatoo is not known to breed north of Perth, and therefore the habitat available within the project footprint is not

expected to support breeding of this species. The project footprint is outside of the modelled distribution of the Baudin's Black Cockatoo (DSEWPaC 2011c). If Baudin's Black Cockatoo occurs within the project footprint, it is likely only as a vagrant. The loss of 11.2ha of foraging habitat plus 106 mature Eucalypts, predominantly Marri, is therefore considered most unlikely to significantly reduce the population size of this species in WA.

Rainbow Bee-eater

The project will result in the loss of 10.02ha of habitat suitable for Rainbow Bee-eater including Eucalypt woodland over grasses and swampland. Given the widespread distribution of Rainbow Bee-eater across much of Australia, its adaptability to disturbance and the availability of suitable habitat outside of the project footprint in the adjacent Whiteman Park, and Gnangara-Moore River State Forest to the north, it is unlikely that the project will result in a significant impact to this species.

Western Brush Wallaby

Western Brush Wallaby is known to occur in Whiteman Park, where it occupies open woodland. This species generally inhabits open forest and woodland, mallee, heathland and areas of low open heathland and scrubby thickets. It is known to avoid pasture and areas with dense understorey (IUCN 2016). No direct or indirect evidence of this species was recorded in the project footprint during the field survey. While some suitable habitat occurs within the project footprint, given the highly fragmented nature of this habitat, it is unlikely to support a population of this species. The loss of 15.62ha of potential habitat in the project footprint is unlikely to be significant.

Quenda

Quenda is present within Whiteman Park and potential diggings were recorded within the project footprint. It occupies a range of habitats, typically with dense ground cover. The loss of 10.0ha of potential habitat is unlikely to significantly reduce local populations of this species given that the majority of vegetation within the project footprint is degraded with little to no understorey, which is necessary to provide shelter for Quenda during the day. Extensive suitable habitat for Quenda is available within the adjacent in Whiteman Park, and to the north in the Gnangara-Moore River state forest.

2.2.4.5 Proposed management measures for terrestrial fauna

The following fauna management measures will be implemented to ensure impacts to terrestrial fauna are minimised and mitigated:

- Fauna encounter procedures to be established and implemented for the construction phase
- Construction workers to undergo induction in relation to fauna species likely to occur and habitats and locations within the project footprint likely to support such species to ensure if such species are encountered, they are given the opportunity to move on
- Visual inspection by fauna specialist of potential black cockatoo breeding trees, prior to clearing for construction, to ensure hollows are not actively in use.
- Visual inspection for Rainbow Bee-eater nests prior to clearing for construction to ensure no active nests will be disturbed.
- Fauna translocation procedures to be prepared and implemented, as required.
- Planting and/or revegetation using species suitable for foraging by three species of black cockatoo to be undertaken in a nearby conservation reserve and on roadsides, where practicable.

2.2.5 Aboriginal heritage

2.2.5.1 EPA Objective for Aboriginal Heritage

The EPA objective for heritage is identified below.

Table 13 EPA factor and objective for heritage

Factor	Objective
Heritage	*To ensure that historical and cultural associations are not adversely affected.*

2.2.5.2 Existing information on Aboriginal Heritage

An Aboriginal heritage survey of the project footprint will be conducted prior to the commencement of construction. A desktop search of the Department of Aboriginal Affairs Aboriginal Heritage Inquiry System was undertaken on 19 May 2016 within a search area which includes the project footprint and a buffer. This search identified six (6) registered heritage sites in the vicinity of the project footprint. Five (5) of these occur within the project footprint (Figure 7). The search report is provided in Appendix E.

The sites are identified below.

Table 14 Registered Aboriginal Sites within the project footprint and in close proximity to the footprint

Site ID	Site Name	Site Type
551	Lord Street North 1	Ceremonial
552	Lord Street North 2	Ceremonial, Mythological, Water Source
3692	Bennett Brook: in toto	Mythological
3744	Marshalls Paddock	Skeletal Material / Burial
3840	Bennett Brook: Camp Area	Artefacts / Scatter, Ceremonial, Fish Trap, Historical, Man-made Structure, Mythological, Skeletal Material / Burial, Camp, Hunting Place, Plant Resource, Water Area

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Legend

Study Area

Project footprint

Department of Aboriginal Affairs Aboriginal Heritage Inquiry System

Aboriginal heritage

Place ID: 3525
Place ID: 17316
Place ID: 4377
Place ID: 17839
Place ID: 4376
Place ID: 15118
Place ID: 25822
Place ID: 551
Place ID: 552
Place ID: 3747
Place ID: 3692
Place ID: 18439
Place ID: 3745
Place ID: 22643
Place ID: 3417
Place ID: 3759
Place ID: 22643
Place ID: 20030
Place ID: 21432
Place ID: 3639
Place ID: 3746
Place ID: 3906
Place ID: 3611
Place ID: 3613
Place ID: 22159
Place ID: 3744
Place ID: 3536
Place ID: 4367
Place ID: 3840
Place ID: 3997
Place ID: 3720
Place ID: 21504
Place ID: 3488

The Vines
Aveley
Ellen Brook
Swan River
Ellenbrook
Lexia
Cullacabardee
Whiteman Park
Whiteman
Ballajura
Herne Hill
Middle Swan
West Swan
Caversham
Freeway Industrial Area
St Lawrence Park
Lightning Swamp Bushland
Beechboro
Seine Park
Maguire Park
Altone Park
Noranda
Noranda Sporting Complex
Arbor Park
Rosher Park
Lockridge
Swan District Hospital
Viveash
Midland Oval
Midland Gate Shopping Centre
Woodbridge
Lions Park
Jubilee Reserve
Guildford
Midland Central

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Date: 14/06/2016 Version: 2 Job No: 247607

Coordinate System: GDA 1994 MGA Zone 50

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Figure 7: Aboriginal heritage sites

2.2.5.3 Assessment of potential impacts to Aboriginal heritage

There is potential for the proposed works to disturb on one or more sites of Aboriginal heritage significance.

2.2.5.4 Proposed management measures for Aboriginal heritage

In the event that a site of Aboriginal heritage significance is identified within the project footprint, and disturbance to the site is unavoidable, MRWA will apply for consent to disturb under Section 18 of the *Aboriginal Heritage Act 1972.*

2.3 Environmental impact assessment of minor aspects

2.3.1 Acid sulphate soils

2.3.1.1 EPA Objective for acid sulphate soils

Acid sulphate soils can be assessed under the EPA objective identified below:

Table 15 EPA factor and objective relevant to acid sulphate soils

Factor	Objective
Terrestrial Environmental Quality	*To maintain the quality of land and soils so that the environmental values, both ecological and social, are protected*

2.3.1.2 Existing information on acid sulphate soils

Acid sulphate soils (ASS) are naturally occurring soils, sediments or organic substrates that are formed under water logged conditions. These soils are rich in iron sulphide materials or their oxidation products. Under water logged conditions, these soils are benign; however, when exposed to air through excavation, lowering of the water table or drainage, the sulphides react with oxygen to form sulphuric acid. Release of this sulphuric acid from the soil can in turn release iron, aluminium, and other heavy metals (particularly arsenic) within the soil as the acidic conditions leach metals. Once mobilised, the acid and metals can create a variety of adverse impacts including vegetation death, seeping into and acidifying groundwater and surface water bodies killing fish and other aquatic organisms, and degrading concrete and steel structures.

ASS in Western Australia are regulated under the *Contaminated Sites Act 2003* (CS Act) and the *Environmental Protection Act 1986* (EP Act). The Western Australian Planning Council (WAPC) and Western Australian Department of Environmental Regulation (DER) provide guidance for the management of potential acid sulphate soils (PASS) and actual acid sulphate soils (AASS) for development projects.

DER's broad scale ASS risk maps were reviewed on Landgate's Shared Land Information Platform (SLIP) (Landgate 2016) to determine the probability of PASS occurring across the project area. The project footprint was overlaid on these maps to highlight any high risk areas. This is depicted in Figure 8 which indicates that the majority of the project footprint has a low to extremely low potential of exposing ASS. A section of the project footprint between Woollcott Avenue and Whiteman Drive East (approximately 800m in length) indicated a high risk for the occurrence of ASS. The project footprint also transects a smaller section of potentially high ASS risk directly north of Rugby Street.

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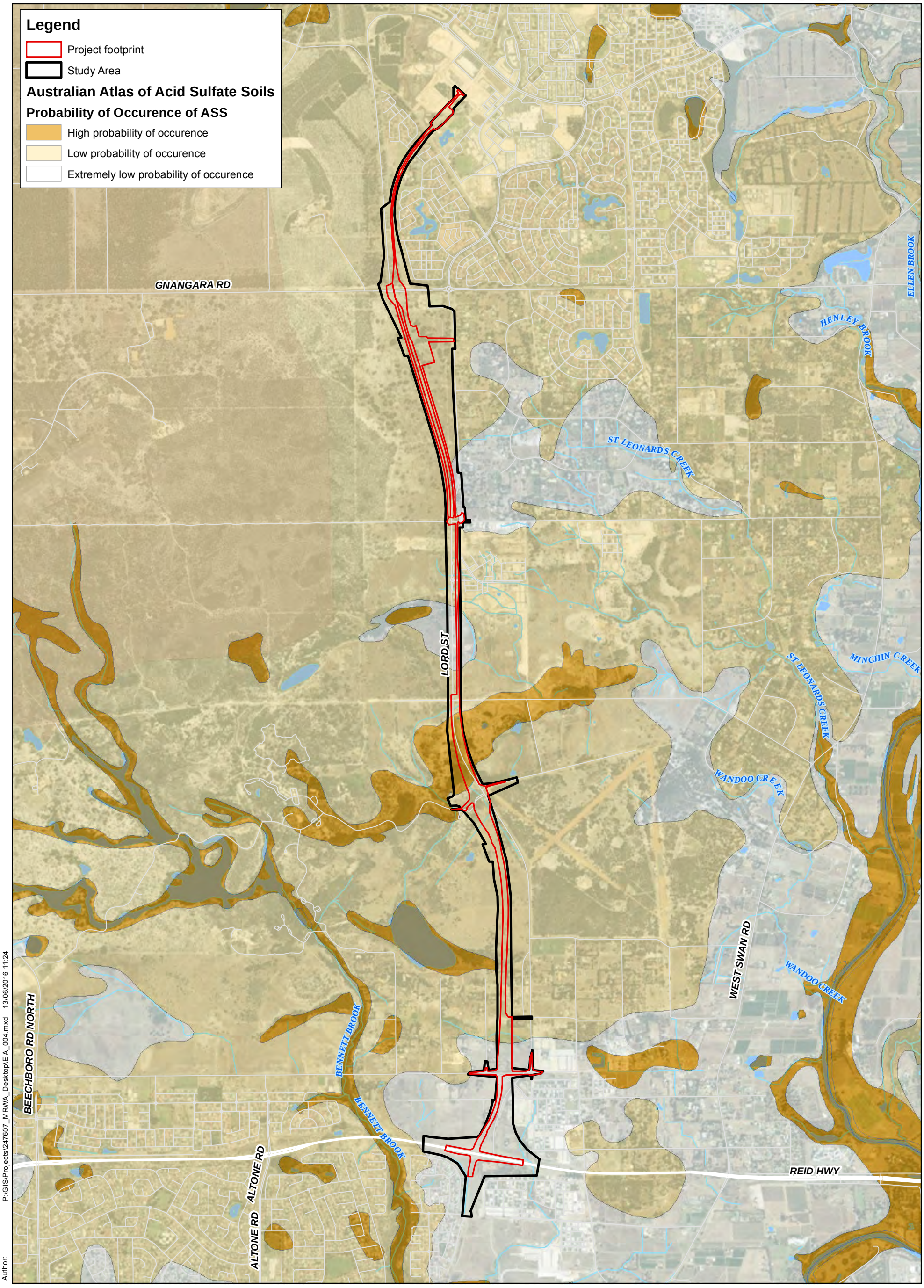

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Coordinate System: GDA 1994 MGA Zone 50

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Figure 8: Probability of occurence of Acid Sulfate Soils

2.3.1.3 Assessment of potential impacts from disturbance of acid sulphate soils

The project transects two areas with a high probability of containing ASS. The uncontrolled disturbance of ASS can lead to potential environmental impacts including the contamination of groundwater resources through the release of acid, arsenic, heavy metals and other contaminants.

Locally, the groundwater system surrounding the project footprint is utilised by landowners to extract water for agriculture and domestic purposes. In addition, the high ASS risk area between Woollcott Avenue and Whiteman Drive East borders the Gnangara UWPCA to the north. The Gnangara UWPCA defines the central area of the Gnangara groundwater system that provides Perth's public water supply. The uncontrolled disturbance of ASS within this area has the potential to release contaminants into the Gnangara groundwater system.

The disturbance of ASS can also increase concentrations of contaminants and cause acidification of sediments and surface waters which can potentially lead to fish kills. The smaller section of high ASS risk to the north of Rugby Street is situated in close proximity to the Swan River Catchment Area. Uncontrolled disturbance of ASS in this zone has the potential to release contaminants into this catchment area and generate local and/or downstream impacts.

2.3.1.4 Proposed management measures for acid sulphate soils

Prior to the commencement of construction, a detailed ASS investigation will be undertaken, focusing on areas identified as having a high probability of ASS as outlined above. The investigation will be undertaken in accordance with guidance provided in *Identification and investigation of acid sulfate soils and acidic landscapes* (DER 2015a) to verify presence or absence of PASS/AASS.

In the event that final design incorporates the construction of underpasses, it is likely that dewatering will be required. If dewatering or excavation of greater than 100m^3 of soil is required, it will be necessary to undertake an ASS investigation to determine the indicators of ASS within the excavation area.

Based on the outcome of the ASS Investigation and in the event that dewatering is required for the construction of underpasses, additional investigations may be required to inform the development of an ASS Management Plan (ASSMP). This may include:

- Further ASS investigation around the cone of depression (if not targeted as part of the initial ASS investigation) and other areas where data gaps or highly variable geology has been identified;
- Analysis of metals and other contaminants to assess the leaching potential if acidic conditions occur as a result of dewatering. This would also help to determine appropriate disposal options;

Note that hydrogeological investigations will be undertaken prior to construction.

The ASSMP will be developed in accordance with guidance provided in the *Treatment and Management of soils and water in acid sulfate soil landscapes* (DER 2015b) in order minimise any potential impacts of ASS within the project area.

2.3.2 Air quality

2.3.2.1 EPA Objective for air quality

The EPA objective for air quality and greenhouse gases is identified below.

Table 16 EPA factor and objective for air quality.

Factor	Objective
Air quality	*To maintain air quality for the protection of the environment and human health and amenity*

2.3.2.2 Existing information on air quality

Criteria relevant to both the operational and construction phase of the EBRT are stipulated by the National Environment Protection Council (NEPC) under the Ambient Air Quality (AAQ) National Environment Protection Measure (NEPM) and Air Toxics NEPM. These NEPMs are adopted on a national level, including by the Western Australia Environment Protection Authority (EPA), and describe the following:

- AAQ NEPM
  - Establishes ambient air quality standards and monitoring and reporting protocols for listed air pollutants. The seven listed pollutants are considered as key indicators of regional air quality
- Air Toxics NEPM
  - Establishes an identification process for sites where exceedances are likely to occur, or potential exists for significant population exposure, and provides a nationally consistent approach to monitoring. Exceedance of the stipulated monitoring investigation levels requires further investigation.

A summary of the air quality criteria applicable to construction and operation of the project is provided in Table 17 and Table 18. These criteria apply at any point within a property considered as a sensitive receptor. The former Department of Environment and Conservation (DEC) (now DER) defines sensitive receptors as the following (DEC 2011):

'Individuals/communities/components of the environment which could be adversely affected by emissions such as people in dwellings, schools, hospitals, nursing homes, child care facilities, offices, public recreation areas that exist now and in the future and protected wetlands.''

The primary pollutant of concern for construction phase are $PM_{2.5}$ and PM_{10} (particles with aerodynamic diameter less than 2.5 µm and 10 µm, respectively). For the operational phase, major road vehicle pollutants are CO, $PM_{2.5}$ and PM_{10}, NO_x and VOCs (VOCs are pollutants listed under the Air Toxics NEPM).

Table 17 Ambient Air Quality Standards (NEPC 2016)

Pollutant	Averaging period	Maximum concentration standard	Maximum allowable exceedances	Goal by 2025
Carbon monoxide (CO)	8 hours	9 ppm	1 day a year	N/A
Nitrogen dioxide (NO_2)	1 hour	0.12 ppm	1 day a year	N/A
	1 year	0.03 ppm	None	N/A
Ozone (O_3)	1 hour	0.10 ppm	1 day a year	N/A
	4 hours	0.08 ppm	1 day a year	N/A
Sulfur dioxide (SO_2)	1 hour	0.20 ppm	1 day a year	N/A
	1 day	0.08 ppm	1 day a year	N/A
	1 year	0.02 ppm	None	N/A
Lead (Pb)	1 year	0.50 µg/m^3	None	N/A
Particles as PM_{10}	1 day	50 µg/m^3	None	N/A
	1 year	25 µg/m^3	None	N/A
Particles as $PM_{2.5}$	1 day	25 µg/m^3	None	20 µg/m^3
	1 year	8 µg/m^3	None	7 µg/m^3

Table 18 Air Toxics NEPM monitoring investigation levels (NEPC 2011).

Pollutant	Averaging period	Maximum concentration
Benzene	Annual average	0.003 ppm
Beno-a-pyrene as a marker for Polycyclic Aromatic Hydrocarbons	Annual average	0.3 ng/m^3
Formaldehyde	24 hours	0.04 ppm
Toluene	24 hours	1 ppm
	Annual average	0.1ppm
Xyelenes	24 hours	0.25 ppm
	Annual average	0.2 ppm

The DER conducts air quality monitoring for AAQ NEPM pollutants across a network of monitoring stations. Stations closest to the EBRT are located at Caversham and Duncraig. These stations are detailed below in Table 19. Air quality described by observations recorded at the Caversham monitoring station are expected to reflect that of the EBRT site based on the surroundings of each station, detailed in Table 19. All monitoring is completed in accordance with AAQ NEPM requirements. Lead and sulfur dioxide are not monitored at either location as this pollutant has not been identified as having potential to cause impacts within the air shed.

Table 19 Summary of DER monitoring stations nearest to the EBRT (DER 2015c).

Pollutant	Caversham	Duncraig
CO	✓	✓
NO_2	✓	✓
O_3	✓	
SO_2		
PM_{10}	✓	✓
$PM_{2.5}$	✓	✓
Station surrounds	Semi-rural. Low density housing. Some regional brick manufacturing.	Moderate/high density housing, moderate to high traffic flow. Located 200 m west of the Mitchell Freeway.

The AAQ NEPM was revised and updated in February 2016. Accordingly, previous assessments of monitored levels of AAQ NEPM pollutants utilised criteria which varies slightly to that presented in Table 17. Compliance with previous NEPM criteria may not necessarily comply with current criteria. The following points describe main changes to AAQ NEPM standards:

- Addition of an annual averaging period for particulates as PM_{10}
- Reduction of maximum allowable exceedances of the PM_{10} 24-hour averaging period standard (reduced from 5 allowable exceedances to none)
- Transition of $PM_{2.5}$ standards and goals from advisory reporting standards to regulatory standards
- Introduction of stricter $PM_{2.5}$ goals with the aim of achieving compliance by 2025

Monitored levels of AAQ NEPM pollutants at locations representative of the EBRT air shed, for the most recent data set (year of 2014) are provided in Table 20 to Table 25. At the time of assessment levels of $PM_{2.5}$ for both 24-hour and annual averaging periods exceeded the relevant advisory reporting standards. In addition, monitored levels of PM_{10} for a 24-hour averaging period exceeded the standard at Caversham; however, the NEPM goal was met as no more than five exceedances were observed. Compliance with both the current and previous AAQ NEPM standards is shown in Table 20 to Table 25.

Table 23 and Table 24 demonstrate that exceedances of current AAQ NEPM standards already occur within the existing environment. These exceedances are largely caused by wind-blown dust from strong breezes (commonly off the sea), generation of particulates ($PM_{2.5}$ and PM_{10}) during bush fires, and operation of wood heaters during winter.

Table 20 Summary of monitored NO_2 levels for 2014 (1-hour and annual averaging period) (DER 2015c).

Monitoring station	1-hour averaging period (ppm)		Annual Mean (ppm)	Compliance 2014 NEPM	Compliance 2016 NEPM
	Max	2nd highest			
Caversham	0.033	0.033	0.006	Yes	Yes
Duncraig	0.048	0.030	0.006	Yes	Yes

AAQ NEPM standard – 0.12 ppm for a 1-hour averaging period and 0.03 ppm for an annual averaging period.

Table 21 Summary of monitored O_3 levels for 2014 (1-hour averaging period) (DER 2015c).

Monitoring station	1-hour averaging period (ppm)		Compliance 2014 NEPM	Compliance 2016 NEPM
	Max	2nd highest		
Caversham	0.091	0.071	Yes	Yes

AAQ NEPM standard – 0.10 ppm for a 1-hour averaging period.

Table 22 Summary of monitored O_3 levels for 2014 (4-hour averaging period) (DER 2015c).

Monitoring station	4-hour averaging period (ppm)		Compliance 2014 NEPM	Compliance 2016 NEPM
	Max	2nd highest		
Caversham	0.073	0.061	Yes	Yes

AAQ NEPM standard – 0.08 ppm for a 4-hour averaging period.

Table 23 Summary of monitored PM_{10} levels for 2014 (24-hour averaging period) (DER 2015c).

Monitoring station	24-hour averaging period (µg/m³)		Compliance 2014 NEPM	Compliance 2016 NEPM
	Max	6th highest		
Caversham	52.6	35.7	Yes	**No**
Duncraig	53.0	29.6	Yes	**No**

AAQ NEPM standard – 50 µg/m3 for a 24-hour averaging period

Table 24 Summary of monitored $PM_{2.5}$ levels for 2014 (24-hour and annual averaging periods) (DER 2015c).

Monitoring station	24-hour averaging period (µg/m^3)		Annual mean (µg/m^3)	Compliance 2014 NEPM	Compliance 2016 NEPM
	Max	6th highest			
Caversham	39.3	16.1	8.1	Yes	**No**
Duncraig	47.6	15.9	7.6	Yes	**No**

AAQ NEPM standard – 25 µg/m3 for a 24-hour averaging period.

Table 25 Summary of monitored CO2 levels for 2014 (8-hour averaging period) (DER 2015c).

Monitoring station	8-hour averaging period (ppm)		Compliance
	Max	2nd highest	
Caversham	0.7	0.7	Yes
Duncraig	1.9	1.7	Yes

AAQ NEPM standard – 9 ppm for an 8-hour average

2.3.2.3 Assessment of potential impacts to air quality

The construction phase of the project may result in short term, localised dust impacts which have the potential to cause nuisance to nearby resident. These impacts will be limited given the project footprint size in relation to the entire air shed, and impacts will cease once construction is complete.

Particulate levels for the existing environment have been shown to exceed Air NEPM criteria at times (Table 23 and Table 24). Thus it is likely that construction activities will create exceedances of $PM_{2.5}$ and PM_{10} 24-hour averaging period standards at times in limited locations. The following factors will influence the impact of construction activities on existing PM_{10} and $PM_{2.5}$ levels at sensitive receptors:

- Relative location of sensitive receptors to construction activities
  - Sensitive receptors located at increased distances from the construction site/activities are less likely to experience adverse impacts
- Strength of wind and wind direction
  - The direction of wind will influence which receptors are likely to be impacted. Calm winds are less likely to create impacts at receptors located at a distance due to reduced wind-blown dust.
- Extent of activities (i.e. surface area of construction site)
  - An increased ground surface area affected by construction works will increase the likelihood of creating adverse impacts.
- Moisture content of soil
  - Disturbance of soil with an elevated moisture content is less likely to create adverse impacts
- Type of activities being completed
  - The type of work being completed affects the method and extent of soil disturbance

Operation of the EBRT is proposed to increase the total number of bus movements; however, this is expected to result in a reduction of private passenger vehicle movements.

2.3.2.4 Proposed management measures for air quality

The following mitigation measures will be implemented to minimise dust impacts during the construction phase:

- Use of water trucks or similar to maintain soil moisture of exposed surfaces, particularly during high wind conditions, to limit the likelihood/severity of wind-blown dust events
- Visually monitoring for dust during clearing and construction activities
- Restrict the area affected by construction activities at any one time, in order to control generation of dust

No mitigation measures are proposed or required for operation of the project.

2.3.3 Contaminated sites

2.3.3.1 EPA Objective for contamination

Contaminated sites can be assessed under the EPA objective identified below:

Table 26 EPA factor and objective relevant to contaminated sites

Factor	Objective
Terrestrial Environmental Quality	*To maintain the quality of land and soils so that the environmental values, both ecological and social, are protected*

2.3.3.2 Existing information on contamination

Contamination, in relation to land, water or a site, is defined as having a substance present in or on that land, water or site at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value *(Contaminated Sites Act 2003*, hereafter referred to as the CS Act).

The CS Act was introduced to identify, record, manage and clean up contamination in Western Australia. Land owners, occupiers and polluters must report known or suspected contaminated sites to the DER. Investigating and cleaning up contaminated sites is, in most cases, the responsibility of the polluter or current site owner. Contaminated Sites are regulated by the DER. The DER administers and enforces the CS Act and *Contaminated Sites Regulations 2006*. This includes classifying sites (in consultation with the Department of Health) which has specific expertise in assessing public health risk from site contamination.

DER Contaminated Sites Database

A review of the DER online contaminated site database was undertaken in April 2016 using a 2 km search radius of the study area, incorporating these suburbs:

- Ellenbrook
- Whiteman Park
- Henley Brook
- Brabham
- Bennett Springs; and
- Dayton

The search revealed two records of contaminated sites, within 2 km of the study area.

Details of the Contaminated Sites Database search have been summarised in Table 27. The Basic Summary of Records (DER 2016b and DER2016c) for the sites listed is presented in Appendix F.

Table 27 Known or suspected contaminated sites in the vicinity of the project area

Address	Distance from Site	Direction from Site	Classification	Details
91 Benara Road, Caversham	1.5km	South	Remediated – Restricted Use	The site has asbestos contaminated fill on the central portion of the Western Boundary. Current land uses include a caravan park and historical vineyards. A soil investigation was carried out in 2012/2013 to facilitate a proposed accommodation development in the West and North-west sections of the site. Asbestos containing material (ACM) was found in the proposed development area and either excavated and stockpiled for future onsite containment or left in situ and covered with clean fill.
State Forest 65, Lexia (Former Gnangara Liquid Waste Facility)	250m	West	Possibly contaminated – Investigation Required	Visual evidence of a hydrocarbon sheen was identified on groundwater from site monitoring bore in 2010. Limited remedial works were undertaken to remove the contaminated groundwater from the bore. Retesting in 2012 showed hydrocarbons still present in the bore. This monitoring bore requires further remediation to eliminate the hydrocarbon impacts. Details of this site are described in the below section.

Direct consultation with DER

As part of this EIA, DER were also consulted directly to determine whether there were any sites within the project footprint or in close proximity to it, that were either in the process of being classified and/ or that were not yet listed on the publically available database. DER reported that one 'Source Site' exists close to the project footprint and provided a Detailed Summary of Records (DSR) search response for the former Gnangara liquid waste facility (Ref State Forest 65, Lexia WA, 6065) (DER 2016b) (Refer Appendix F). This site is located approximately 250m to the west of the project footprint and falls within a Priority 1 source protection area of the Gnangara UWPCA. The site was classified in July 2007 as possibly contaminated –Investigation required under the CS Act. The site was formerly used as a sewage effluent treatment facility and waste disposal site, which is considered to be a land use that has the potential to cause contamination in accordance with the guideline *Potentially Contaminating Activities, Industries and Land uses* (DoE 2004c). A number of investigations have been undertaken at the former facility to date with 16 groundwater monitoring wells being installed in 1976. These wells were monitored bi-annually between 1976 and 1982. Results of the bi-annual groundwater monitoring were not made available to the DEC Land and Water Quality Branch at the time that the site was classified.

Groundwater investigations undertaken in 1994 identified a groundwater contaminant plume (ammonia and heavy metals) which extended from the source site in a south to south easterly direction affecting land south of the Gnangara Road. The then Department of Environmental Protection requested in January 1994, that continual assessment and monitoring of the plume be undertaken on a regular basis, however no further information has been received to date (DSR 2016a).

Preliminary Site Investigation, Former Liquid Waste Facility, Lexia (Golder 2015)

Aurecon reviewed the Preliminary Site Investigation (PSI) of the former Liquid Waste Facility (Gnangara liquid waste facility) (Golder 2015) as part of this EIA. The objective of the PSI was to assess the potential for contamination and the types of contaminants present at the site based on current and historical land use activities. Based on the findings of the PSI, the potential for soil contamination was assessed to be high. Based on the sites former use as a liquid waste disposal facility the following contaminants of concern were highlighted as being potentially present in soils and groundwater:

- Nutrients
- Metals
- Phenols
- Pathogens
- Organic acids
- Alcohol
- Biological Oxygen Demand (BOD) and total suspended solids (TSS) where highlighted as potential issues in groundwater only.

Additional contaminants which may be present in soil and groundwater and that were associated with the sites former use as a landfill were reported to include:

- Poly chlorinated biphenyls (PCBs);
- Alkanes
- Sulphides
- Polycyclic aromatic hydrocarbons (PAH)
- Monocyclic aromatic hydrocarbons (MAH)
- Landfill gasses (including methane, carbon monoxide and hydrogen sulphide)
- Asbestos in soils

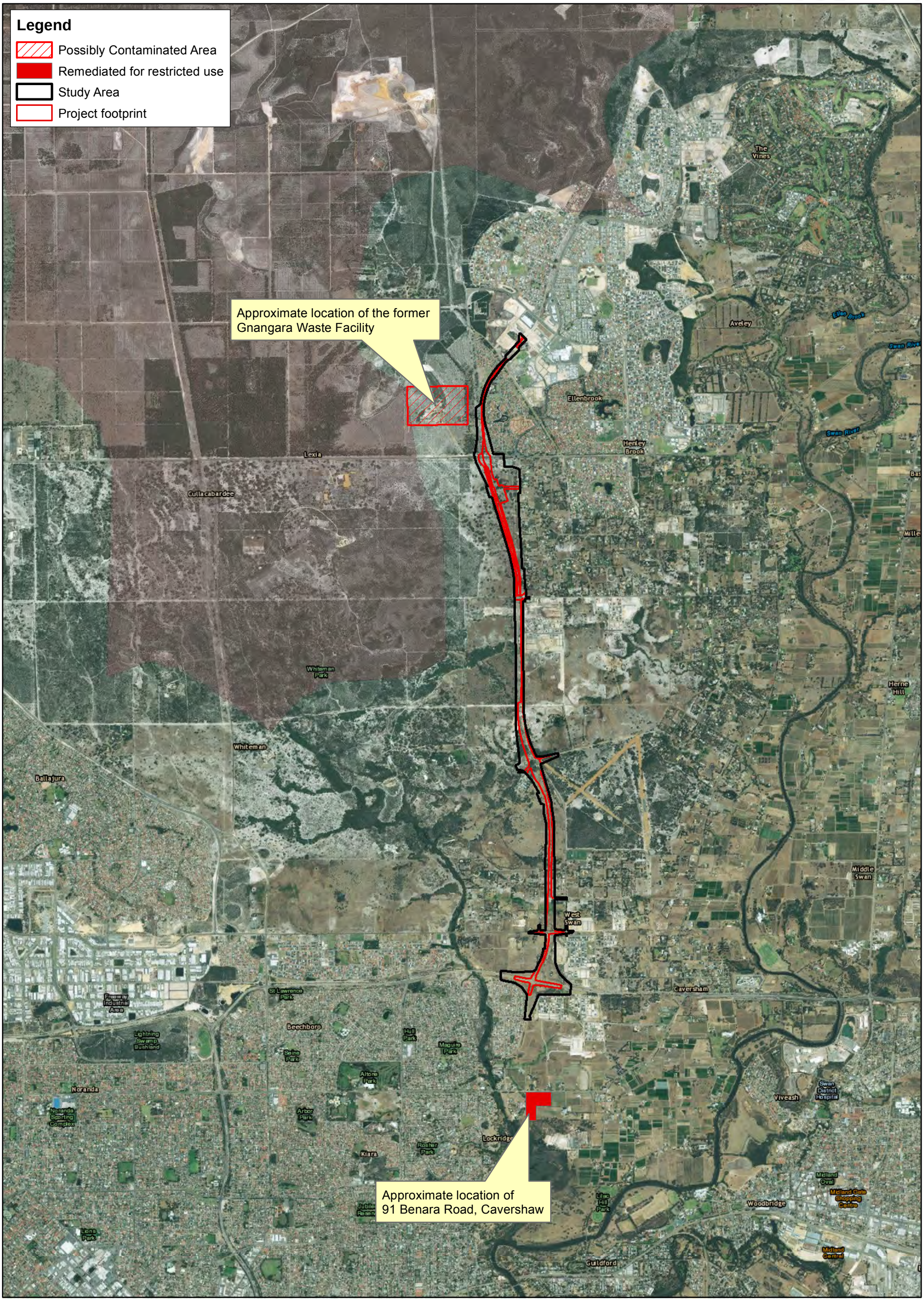
Previous investigations at the site have indicated that a groundwater plume originating from the site in a south, south-easterly direction from the site towards the project footprint. The location of the Gnangara mound and Gnangara UWPCA which is designated as a Priority 1 Public Drinking Water Area relative to the site means that this would be considered a key receptor to potential contamination originating from the former liquid waste facility. Other receptors outlined in the PSI Report included terrestrial ecology, recreational users of the State Forest and Whiteman's Park and residents of surrounding residential areas.

The PSI recommended that further investigation would be required to assess the nature and extent of the waste (source) material and its impact to soil and groundwater including the suitability of the existing groundwater monitoring network for future investigations. It was recommended that a sampling and analysis plan (SAP) be prepared and incorporate the following:

- Test pitting and or boreholes to confirm the presence and extent of buried waste;
- Review of the current monitoring well network and replacement of any that are not serviceable.

Figure 9 depicts the location of potentially contaminated sites in the vicinity of the EBRT project footprint.

aurecon



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Coordinate System: GDA 1994 MGA Zone 50

MRWA Ellenbrook Bus Rapid Transit EIA and EMP

Figure 9: Possibly Contaminated and Remediated Sites

2.3.3.3 Assessment of potential impacts

As described in Table 27 the site located at 91 Benara Road, Caversham is not considered to pose a risk to the proposed EBRT as the primary source of contamination on the site is asbestos impacted fill materials in the subsurface. As asbestos is not a mobile contaminant with the potential to migrate, the potential risks to the study area for this site are considered low. According to the Contaminated Sites Database Detailed Summary of Records (DSR) (DER 2016b), the site has been classified as remediated for restricted use as lead and Dieldrin impacted soils were also present on the site, but have since been excavated and disposed offsite as part of the remedial program undertaken in 2013. Furthermore, the asbestos impacted fill materials have been covered with clean fill or have been built over and sealed at surface with a geotechnical warning barrier. Groundwater beneath the site is reported to be impacted with elevated concentrations of copper and zinc at concentrations exceeding the ANZECC 2000, Aquatic Ecosystems Freshwater guidelines. Given that the site is located approximately 1.5 km to the south of the project footprint, the risk of contamination migrating from this site towards the proposed EBRT development is considered to be low.

Based on the review of background information relating to the former Gnangara liquid Waste Facility, there is potential that the contaminant plume in groundwater originating from the site in a south, south-easterly direction from the site, in the inferred direction of groundwater flow (DoW Perth Groundwater Atlas) towards the EBRT project footprint. According to the DoW Groundwater Atlas, the anticipated groundwater depth at the former Gnangara liquid waste facility is around 10 m below ground surface and is approximately 5 m below ground level within the project footprint. Potential construction impacts may include but are not limited to the following:

- Construction activities may come into contact with the contaminant plume which originates from the former waste facility. According to the DSR (DER 2016b) it is noted that the groundwater impacts have not been delineated. Potentially contaminated groundwater encountered would need to be assessed and managed as part of the project;
- Construction activities may have the potential, albeit a low probability low risk to create preferential pathways if groundwater is intercepted depending on the depth of the proposed excavations and of service corridors. There is potential for the groundwater contaminant plume originating from the former waste facility to migrate further south / south east towards the project footprint; however this is considered a low probability risk; and
- De-watering as part of the project construction phase has the potential to draw contaminated groundwater towards the project footprint if not managed appropriately. Potentially contaminated groundwater extracted as part of the dewatering process would need to be a licenced activity and all contaminated groundwater would need to be managed appropriately during the construction phase of the project.

2.3.3.4 Proposed management measures for contamination

Consultation with DER will be undertaken for any proposed disturbance of soils or dewatering that may potentially impact on contaminated soils or groundwater. Following consultation with DER a Preliminary Site Investigation (PSI) and/or Detailed Site Investigation (DSI) may subsequently be required to assess the nature and extent of contaminated soils and groundwater within and up hydraulic gradient of the proposed project footprint. The PSI and/or DSI if required will be prepared in accordance with relevant WA DER Contaminated sites Guidelines. A Construction Environmental Management may also be required to address the following factors associated with contamination:

- Handling, management and treatment of contaminated soils;
- Handling, management and treatment of contaminated groundwater;
- Monitoring of groundwater and de-watering management;
- Occupational health and safety; and

- Personal protective equipment

2.3.4 Dieback

2.3.4.1 EPA Objective for dieback

The EPA objective most relevant to dieback and soil is for flora and vegetation, and is defined as:

Table 28 EPA factor and objective for flora and vegetation

Factor	Objective
Flora and vegetation	*To maintain representation, diversity, viability and ecological function at the species, population and community level.*

2.3.4.2 Existing information on dieback

A dieback survey of the project footprint was undertaken by Terratree in April 2016 and involved both a desktop assessment and field survey.

The desktop assessment was undertaken to:

- Examine topography and drainage of the assessment area and broader landscape
- Review sample history or Dieback occurrence mapping from within the assessment area and surrounding landscape
- Identify possible disease vectors e.g. tracks, utility corridors and ground disturbance
- Identify any high risk areas (e.g. areas of high disturbance and water-gaining sites).

Data from the Vegetation Health Services (VHS) database identified numerous locations within the neighbouring Whiteman Park which have previously tested positive for *Phytophthora cinnamomi*. Due to their proximity to the project footprint, these results have a significant bearing on assumptions, extrapolations and assessment of disease risk within the assessment area.

Possible vectors for disease within the project footprint include:

- Drainage lines
- Uncontrolled vehicular access in areas of native vegetation
- Earthworks associated with roadworks and construction.

High risk areas within the assessment area include:

- Tracks and roads
- Creeks and gullies
- Water-gaining sites such as culverts and drains
- Areas of high soil disturbance, including roadworks and vehicle activity.

A field survey was undertaken on 19 and 20 January 2016 in an assessment area, which did not include the entire project footprint. The extent of the assessment area is depicted in the full Dieback Survey Report provided at Appendix G.

The assessment area was traversed by vehicle, and areas of native vegetation were inspected intensively on foot. Observations of vegetation health and disease were captured with hand-held GPS units, including georeferenced photographs.

The objectives of the Dieback assessment were to:

- Collect field evidence including visual observations, soil and tissue samples from recently dead indicator species to test for the pathogen's presence;
- Identify and accurately map *Phytophthora* Dieback infestations within the assessment area
- Identify and accurately map Protectable areas within the assessment area.

Dieback Occurrence Categories

The Dieback Interpreters Guidelines (DPaW 2015) were recently updated and now categorise land that has been cleared of native vegetation as 'Excluded' from assessment. Non-vegetated areas that are excluded from assessment include pasture, pits, easements, development, large roads (sealed and unsealed), permanently flooded areas and parkland tree stands. Excluded areas are distinguished from 'Temporarily Uninterpretable' areas by the fact that they cannot regenerate naturally and eventually become Mappable. The Keighery vegetation disturbance scale presented in Table 29 was used to determine the assessability of disturbed areas (DPaW 2015).

Table 30 presents the Assessability of vegetated and non-vegetated areas, which includes the Excluded category (DPaW 2015). The Temporarily Uninterpretable category is allocated to areas of native vegetation which have been disturbed, but will recover over time and become Interpretable and therefore Mappable. Examples of Temporarily Uninterpretable areas include vegetation that has been impacted by fire, grazing, timber harvesting, flooding or mining and rehabilitation. Recovery in Temporarily Uninterpretable areas may take longer than three years (DPaW 2015).

The vegetation of Uninterpretable areas can range from Pristine to Very Good; however, whether the pathogen is present in resistant hosts or as Zoospores in permanent water bodies is indeterminable. Uninterpretable areas that meet the protocols for identifying Protectable Areas (DPaW 2015) are managed as being both Infested and Uninfested so that the pathogen is neither imported into, nor exported from, these areas.

Table 29 Keighery Vegetation Disturbance Scale and Assessability (Keighery 1994, as referenced in DPaW 2015)

Assessability	Scale		Condition
Assessable	1	Pristine	Pristine or nearly so, no obvious signs of disturbance.
	2	Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
	3	Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Possibly Assessable, discretion required	4	Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Not Assessable, Excluded from assessment	5	Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
	6	Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as "parkland cleared" with the flora comprising weed or crop species with isolated native trees or shrubs.

Table 30 Assessability of vegetated and non-vegetated areas (DPaW 2015)

	Phytophthora occurrence category	Typically present	May be present
Naturally vegetated areas (*Phytophthora* occurrence categorisation is or will be possible) Small un-vegetated areas can exist and may be included in the assessment area considering total environmental context	INFESTED	Dead and dying reliable indicator species	Healthy reliable indicator species. ISDs that have been killed by other agents
	UNINFESTED	Healthy reliable indicator species	ISDs that have been killed by other agents
	UNINTERPETABLE	Very few reliable indicator species	Occasional reliable indicators, but too few for *Phytophthora* dieback interpretation
	NOT YET RESOLVED	Usually reliable indicator species in an environment not favourable to disease development	Negative sample results for all *Phytophthora* species
	TEMPORARILY UNINTERPRETABLE	Indicator species masked by disturbance. Keighery disturbance rating of 4 or greater Disturbance typically from; fire, harvesting, temporary flooding. Should recover (become interpretable) in 3 years or less	Occasional reliable indicator species, but disturbance prevents accurate placement of *Phytophthora* occurrence boundaries. Recovery time may be longer than 3 years
	DISEASE RISK ROAD	Unformed track with shoulders of interpretable vegetation	Shoulders and batters with regenerated vegetation. Incipient infestation
Non-vegetated areas (*Phytophthora* occurrence assessment is not possible) Can be determined by desktop assessment (aerial photo) Small vegetated areas can exist and may be Excluded from the assessment area considering total environmental context	EXCLUDED	Pasture, pits, easements, infrastructure, large roads (sealed and unsealed) permanent flooding, plantations, parkland tree stands	Sporadic reliable indicator species

The Dieback Interpreters Guidelines (DPaW 2015), define 'Protectable Areas' as those that:

- Have been determined to be free of *Phytophthora* spp. by a registered Dieback Interpreter
- Consists of areas where human vectors are controllable
- Are positioned in the landscape and are of sufficient size such that a qualified Interpreter judges that the pathogen will not autonomously engulf them in the short term
- Includes areas of high conservation and/or socio-economic value

A full description of “Protectable areas’ is provided in the Dieback survey report (Appendix G).

Disease indicator species observed within the assessment area include representatives of the Proteaceae, Myrtaceae and Xanthorrhoeaceae families. *Xanthorrhoea preissii* was the most reliable indicator of disease expression, due to their relative abundance within the project footprint. *Banksia* ssp. were also used to inform disease interpretation where present. Indicator species observed during the field survey are listed in Table 31.

Table 31 Disease indicator species

Family	Species
Myrtaceae	*Eucalyptus marginata*
Proteaceae	*Banksia attenuata*
	Banksia menziesii
	Banksia ilicifolia
Xanthorrhoeaceae	*Xanthorrhoea preissii*
Zamiaceae	*Macrozamia riedlei*

In total, 248.58 ha were assessed, with only 7.4 ha being assessable and 241.2 ha being Excluded, representing 97% of the assessment area. Uninterpretable areas comprise 2.63% (6.55ha) of the assessment area.

A total of three soil and tissue samples were taken from recently dead disease indicator species within the project area. One sample returned a positive result for *Phytophthora cinnamomi* (Table 32). This small infested area is the only assessable vegetation within the assessment area and represents only 0.34% of the overall assessment area (Terratree 2016).

As dieback is widespread within the adjacent Whiteman Park, it is considered likely that dieback is widespread within the project footprint. Accordingly, it is recommended that the majority of the assessment area should be managed as Infested.

Table 32 Sample Results

Sample No.	Species	Easting (GDA 94, Zone 50)	Northing (GDA 94, Zone 50)	VHS Laboratory Results
ETC – S01	Banksia menziesii	*401796*	*6478305*	*P. cinnamomi*
ETC-S02	Xanthorrhoea preissii	*401779*	*6479076*	*Negative*
ETC-S03	Xanthorrhoea preissii	*401789*	*6479501*	*Negative*

Table 33 provides an area statement of the size and proportion of each Dieback mapping category.

Table 33 Dieback Mapping Area Statement

Dieback Occurrence Category	Area (ha)	% Area
Infested	0.85	0.34
Uninterpretable (Unprotectable)	6.55	2.63
Excluded	241.19	97.02
Total	**248.59**	**100**

Sampling procedures are described in full in the attached Dieback Survey Report (Appendix G).

Disease boundaries within the project footprint were not demarcated because no Protectable areas were identified within or adjacent to the assessment area.

The survey was limited by access restrictions, potential pathogen inactivity due to reduced rainfall and survey timing, which may result in false negative results.

The full Dieback Survey Report is provided at Appendix G.

2.3.4.3 Assessment of potential impacts

The majority of the assessment area is 'Excluded' and no 'Protectable' areas have been identified. As dieback is widespread within the adjacent Whiteman Park, as a precautionary measure, the assessment area should be managed as infested (Terratree 2016).

The proposal is unlikely to result in the introduction of dieback to the soil and vegetation of the project footprint.

However, the construction of grade separations may involve excavation for underpasses. In the event that soil is to be removed from the project footprint; inappropriate management of infested soil may result in the spread of dieback pathogen off-site.

Management measures are described below and in Appendix G.

2.3.4.4 Proposed management measures for dieback

Recommendations for managing *Phytophthora* Dieback during the project construction phase include:

- All vehicles and machinery should be inspected on arrival to site and be 'clean on entry' i.e. no soil or vegetative material adhering to the vehicle or machine when arriving on site
- All vehicles and machinery should be inspected before leaving the site and be 'clean on exit' to prevent the spread of Dieback outside the assessment area
- Personnel footwear should be clean on entry to the project footprint, and clean on exit from the project footprint, free from soil or vegetative material
- Any plant species used in revegetation programs should be resistant to the Dieback pathogen to minimise risk to revegetation development and survival. All plants and seedlings should be sourced from Nursery Industry Accreditation Scheme (NIASA) accredited nurseries.
- All soil removed from the project footprint should be disposed of appropriately to ensure that the disease pathogen is not introduced into Protectable areas
- All personnel should be informed about Dieback, in terms of why it poses a significant threat to biodiversity, how the pathogen is spread, and how to avoid spreading it. This information should be incorporated into an induction package for all personnel.

2.3.5 Hazardous substances

2.3.5.1 EPA Objective for hazardous substances

The term ‘’hazardous substance’ describes any substance that has the potential to cause harm to man or the environment. Hazardous substances may have harmful effects on people, either directly through toxic effects, or indirectly through causing a fire or hazardous reaction.

Environmental Assessment Guideline No. 8 (EPA 2013) environmental factors relevant to hazardous substances include Inland Water Quality, Terrestrial Environmental Quality and Human Health. The EPA objectives for these factors are as follows:

The EPA objectives most relevant to hazardous substances are identified below:

Table 34 EPA factors and objective relevant to hazardous substances

Factor	Objective
Inland Waters Environmental Quality	*To maintain the quality of groundwater and surface water, sediment and biota so that the environmental values, both ecological and social, are protected*
Terrestrial Environmental Quality	*To maintain the quality of land and soils so that the environment values, both ecological and social, are protected*
Huma Health	*To ensure that human health is not adversely affected*

In addition, the DoW *Water Quality Protection note 65 – Toxic and Hazardous Substances* (April 2015) provides advice and recommendations for stormwater management and toxic hazardous substances use near sensitive water resources.

EPA objectives for Hydrological Processes and Inland Waters have been addressed in the surface water / drainage section of this EIA (Refer to Section 2.2.2).

2.3.5.2 Existing information on hazardous substances

Hazardous substances may be in the form of a liquid, solid or gas. For the proposed EBRT the term hazardous substance relates primarily to hydrocarbons and the potential for surficial drips and leaks associated with vehicle parking areas which could potentially migrate towards sensitive receptors including the following if not managed appropriately by employing water sensitive urban design (WSUD) principles:

- Gnangara UWPCA; and
- Bennet Brook (which flows into the Swan River).

Several parking areas are proposed (approximately 300 parking bays total) and these proposed parking areas are located within P2 drinking water areas. Refer to Section 2.2.2 of the EIA for further details.

Hazardous substances including contaminants of concern in soil and groundwater, waste materials and asbestos have been addressed in the contamination section of this EIA (Refer to 2.3.3). Hydrocarbons released from vehicles in parking areas would be diffuse and minor point sources originating from vehicles which would eventuate into non-point sources during rain fall events, as they are mobilised by stormwater and run off. Major point sources could result from a single event such as or a major traffic accident.

The following hazardous substances (potential contaminants of concern) would be associated with fuel, oil and lubricants drips and leaks from vehicles during the operational phase of the project:

- Benzene, Toluene Ethyl Benzene and Xylene (BTEX)
- Total Petroleum Hydrocarbons (TPH)
- Polycyclic aromatic hydrocarbons (PAH)

2.3.5.3 Assessment of potential impacts

Spills associated with the storage and handling of chemicals and fuels onsite during the construction phase has the potential to release hazardous substances into the surrounding environment. To mitigate these impacts a Construction Environmental Management Plan (CEMP) will be developed to ensure that use and storage of these substances is strictly managed and controlled.

Spills and leaks from parked vehicles are likely to comprise heavy end hydrocarbon fractions (Carbon chain fractions C10 to C40 as these would be associated with oils and lubricants rather than specifically fuel leaks. Lighter fractions in the C6 to C9 range associated with petrol are considered volatile and would quickly evaporate, which would limit potential impacts from these compounds.

Major fuel and other hydrocarbon spills, and leaks from tanker spills and major road traffic accidents would need to be incorporated into the proposed design considerations for the project.

2.3.5.4 Proposed management measures for hazardous substances

The following management measures will be applied to the handling and storage of hazardous substances onsite during the construction phase of the project and incorporated into a Construction Environmental Management Plan:

- Hydrocarbon and fuel will be stored in a bunded area with at least 125% of storage tank capacity;
- Hazardous substances will be handled and stored in accordance with their respective material safety data sheets (MSDS) and the manufacturer's directions MSDS;
- Hazardous substances will not be stored with 100m of Well Head Protection Zone;
- Refuelling and maintenance of plant and site vehicles will be undertaken in designated areas;
- Spill kits will be available on site and in vehicles and construction personnel will be trained in the use of spill equipment; and
- Where practical, no hazardous substances will be stored within P2 PDWSA

Site specific management measures will be developed and implemented during both the construction and operational phases of the project to govern refuelling onsite.

To ensure that hydrocarbons and other urban pollutants are managed throughout the operational pahse of the project, parking areas would need to be designed in accordance with WSUD principles and the *Stormwater Management Manual for Western Australia* (2004), taking into consideration source of potential contaminants and and run off controls for hydrocarbon management.

Further details specific to proposed management measures for surface water and drainage are outlined in Section 2.2.2.4 of this report.

2.3.6 Heritage (non-Indigenous)

2.3.6.1 EPA Objective for heritage (non-Indigenous)

The EPA objective for Heritage is defined below.

Table 35 EPA objective for heritage

Factor	Objective
Heritage	*To ensure that historical and cultural associations are not adversely affected.*

2.3.6.2 Existing information on heritage (non-Indigenous)

The Heritage Council and State Heritage Office maintain the Inherit database of places of heritage value in Western Australia. A search of the Inherit database on 15 February 2016 identified no places of heritage (non-Indigenous) significance within the project footprint.

2.3.6.3 Assessment of potential impacts to heritage (non-Indigenous)

There will be no impact to places of heritage (non-Indigenous) significance.

2.3.6.4 Proposed management measures for heritage (non-Indigenous)

No management measures are required.

2.3.7 Land tenure

The majority of the land within the study area is owned or managed by the State Government as reserves or freehold land; however, there are a number of privately owned lots within the study area and project footprint. Prior to the commencement of construction on any land, Main Roads will have appropriate authorisation to enter that land for the purposes of construction.

2.3.8 Noise and vibration

2.3.8.1 EPA Objective for noise and vibration

The EPA objectives applicable to noise are given below.

Table 36 EPA objectives for noise

Factor	Objective
Amenity	*To ensure that impacts to amenity are reduced as low as reasonably practicable.*
Human health	*To ensure that human health is not adversely affected.*

The Western Australian Planning Commission State Planning Policy 5.4 (WAPC 2009) provides guidance on noise assessment of transport infrastructure with the aim of protecting people from unreasonable levels of transport noise and encouraging best practise design and construction for new major roads or major redevelopment of existing roads. Based on the concept design (Figure 2), the alignment will consist of several new sections of road located east of existing Lord Street (designated as a primary regional road). As the alignment has several new sections of road, SPP 5.4 criteria as provided in Table 37 are considered to be applicable in assessing operational noise impact from the project.

Table 37 Road traffic noise guidelines based on the SPP 5.4

Period	Target	Limit
Day (6am to 10pm)	55 dB $L_{Aeq(Day)}$	60 dB $L_{Aeq(Day)}$
Night (10pm to 6am)	50 dB $L_{Aeq(Night)}$	55 dB $L_{Aeq(Night)}$

The criteria outlined above apply at any point 1-metre from a habitable façade of a noise-sensitive premises and in at least one outdoor living area. In areas where the above limits are likely to be

exceeded, customised noise mitigation measures should be developed and implemented with a view to achieving the noise targets of the Policy where reasonable and practicable.

The State Planning Policy 5.4 does not address adverse impact from vibration during the construction or operational phase of the project, and therefore guidance on assessment of vibration impact should be drawn from Australian Standards (e.g. AS ISO 2631). Monitoring of vibration will be undertaken during the construction stage of the project to control cosmetic/structural damage to any nearby buildings (refer to the vibration management actions in the section below for details).

2.3.8.2 Existing information on noise and vibration

Existing traffic noise along Lord Street is already high. By 2031 it is expected that many noise sensitive receivers along Lord Street will be exposed to noise levels at or above the SPP 5.4 noise target criteria.

2.3.8.3 Assessment of potential impacts from noise and vibration

Construction of the project, in addition to bus movements on the new road following completion of the project, has the potential to cause adverse noise and vibration impact on sensitive receptors near the alignment, if not properly controlled.

A baseline noise and vibration survey should be undertaken prior to construction in accordance with the SPP 5.4 guidelines to measure existing acoustic conditions impacting on the nearby receptor locations and to ensure appropriate calibration of the acoustic model. The baseline acoustic survey results will also serve as a basis for comparison against the final commissioning measurements upon completion of the busway.

The new EBRT busway will result in a change in bus noise sources including bus frequency, alignment and source height which will change acoustic emissions from the existing roadway (and will vary from the scenarios for which acoustic modelling has previously been undertaken). These changes to the busway should be implemented within an updated acoustic model of the EBRT including any recent changes to residential developments to ensure that the existing barriers will meet the acoustic objectives at all noise-sensitive receivers, and develop any new acoustic treatment (e.g. barriers / façade treatment) if required. As a minimum the Noise Management Plan (NMP) and updated acoustic modelling should be undertaken for the new EBRT busway in accordance with the SPP 5.4 guidelines.

In addition to the operational acoustic assessment outlined above, noise and vibration impact during the construction phase will require acoustic control and planning to minimise adverse impact on the nearby receptors, including control of noise from on-site construction plant and activities, and assessment of potential vibration impact in terms of human response (short-term nuisance impacts) and impact on buildings (potential damage).

2.3.8.4 Proposed management measures for noise and vibration

Noise and vibration control measures will be based on the noise modelling, acoustic assessment and Noise Management Plan as outlined in the previous sections. It is envisaged that the noise control strategy for the project will consist of a combination of the following elements, to be confirmed during the detailed design stage of the project:

- A construction noise and vibration management plan developed in accordance with the *Environmental Protection (Noise) Regulations 1997* including methodologies for noise and vibration monitoring, appropriate working-hours, a suitable approach for any out-of-hours work (if required), impact assessments, noise and vibration monitoring sites, indicative treatment options and a plan for community engagement / response to complaints
- Implementation of noise barriers where required, for control of both construction and operational noise including earth-mounds, berms, barriers or fences. These barriers may be as per the existing arrangements, or new / increased height to control noise emissions from the new EBRT busway.

Where practical, noise barriers should be implemented at an early stage of the construction programme so that they also provide mitigation of construction activity noise.

- Post-opening verification noise surveys at representative receivers to confirm that the acoustic design objectives have been met.

The following vibration management actions are to be implemented in accordance with the developed construction noise and vibration management plan:

- Conduct dilapidation (disrepair) surveys on all buildings and structures within 100m of the works prior to works and post-construction
- Conduct monitoring of vibration during construction to ensure that no damage to property occurs and the peak particle velocity does not exceed 5 mm/s at vibration sensitive receptors

2.3.9 Reserves/conservation areas

2.3.9.1 EPA Objective for reserves and conservation areas

A number of objectives are relevant to reserves and conservation areas. These are identified below.

Table 38 Factors and objectives relevant to reserves and conservation areas

Factor	Objective
Flora and Vegetation	*To maintain representation, diversity, viability and ecological function at the species, population and community level.*
Terrestrial Fauna	*To maintain representation, diversity, viability and ecological function at the species, population and assemblage level.*
Terrestrial Environmental Quality	*To maintain the quality of land and soils so that the environment values, both ecological and social, are protected.*

2.3.9.2 Existing information on reserves and conservation areas

A desktop search of reserves and conservation areas within close proximity to the project footprint was undertaken including a review of a Level 1 biological survey by AECOM (2016) and a search of WA Atlas.

These reserves and conservation areas are summarised in Table 39.

Table 39 Reserves and conservation areas in proximity to the project area

Conservation area	Distance from EBRT corridor (km)	Extent (ha)	Vegetation description	Fauna values
Gnangara Moore River State Forest No. 65 (NorthLink 2015a)	1	106	Banksia dominated woodlands Low lying *Banksia attenuata* woodland or shrubland Northern Spearwood shrublands and woodlands	2.5ha of high value habitat and 28.0ha of moderate value habitat for black cockatoo
Walyunga National Park (DEC 2014; DoE 2016e)	8	1790	Mixture of open forest and open woodland through heath and herb land, to lichens on the granite rocks Flooded gums on river's edge, *Wandoo* woodlands on side of valley, marri and powderbark woodlands and forests in the uplands, jarrah on the high ridges Understory includes *Grevillea wilsonii* and *Adenanthos barbigerus* Heath includes hakeas, grevilleas, isopogons, petrophiles and verticordias	Black cockatoo habitat, grey kangaroos, echidna, woylies, wallabies, euros, reptiles including long necked tortoise and a large variety of bird species
Whiteman Park Bush Forever 304 (NorthLink 2015a; DoP 2000)	<1	1547.9	Vegetated wetland, creek, vegetated uplands Low lying *Banksia attenuata* woodlands or shrublands Uplands: (mainly Bassendean Sands): Eucalyptus calophylla Woodland to Low Open Woodland, often with *E.marginata*, *Melaleuca preissiana, Banksia ilicifolia* or *B.grandis* Wetlands: Open Forest to Low Open Forest of *Eucalyptus rudis, Melaleuca preissiana, M.rhaphiophylla* or *Banksia littoralis*	71.1ha of high value habitat for black cockatoo Quenda and Western Brush Wallaby. Rich assemblage of reptiles, insectivorous and nectarivorous birds
Melaleuca park and Adjacent Bushland, Bullsbrook/Lexia BR399 (DoE 2016j; DoP 2000; NorthLink 2015a)	<1	4150.9	Large sized remnant of Banksia woodlands on Bassendean dunes, combined with a rich suite of damplands and sumplands Tall dune, open water, vegetated wetland, creek, vegetated uplands Uplands: Low Open Forests to Low Open Woodlands of *Banksia attenuata, B.menziesii* or *B.ilicifolia* or combination of these	2.5ha of high value habitat and 27.9ha of moderate value habitat for black cockatoo. Southern brown bandicoot (*Isodon obesulus fusciventer*) Western brush wallaby (*Macropus Irma).* Good assemblage of reptiles.

Conservation area	Distance from EBRT corridor (km)	Extent (ha)	Vegetation description	Fauna values
			Wetlands: Open Forests to Low Open Woodlands of *Eucalyptus rudis, Melaleuca preissiana, M.rhaphiophylla* or *Banksia Littoralis* Dieback *(Phytophthora cinnemoni*) has recently been detected along easements in the park Vegetation condition: Most of bushland in very good condition 5% pristine, >85% excellent to very good, <10% good to degraded, with areas of severe localised disturbance	

2.3.9.3 Assessment of potential impacts to reserves and conservation areas

A small portion of the project footprint ties into the current entry to Whiteman Park; however, this is in a predominantly cleared area, considered to be completely degraded. There will be no impact to conservation areas and the EPA objectives will be met.

2.3.9.4 Proposed management measures for reserves and conservation areas

No management measures are required.

2.3.10 Visual amenity

2.3.10.1 EPA Objective for visual amenity

The EPA objective for visual amenity is identified below.

Table 40 EPA objective for amenity

Factor	Objective
Amenity	*To ensure that impacts to amenity are reduced as low as reasonably practicable.*

2.3.10.1.1 State and Local Planning Policy Framework

Visual Landscape Planning in Western Australia

The *Visual Landscape Planning in Western Australia Manual* (the Manual) is recognised as best practice for undertaking visual landscape assessment and guiding design responses. It provides guidelines applicable to development on private and public land to assist in the protection of significant landscapes.

2.3.10.2 Existing information on visual amenity

Much of the project footprint is aligned with the existing Lord Street transport corridor. The clearing of mature native vegetation may result in adverse visual impact and heightened public sensitivities. This may also give rise to the perception of negative impact on adjacent property values.

The topography of the land adjacent the project footprint is generally flat, resulting in limited ability to overlook the project footprint. The project footprint generally abuts land used for low intensity dry land

agriculture or land reserved for recreation and conservation to the west and extensive areas of urban development to the north, east and south.

The project footprint includes areas that are degraded and in need of restoration and enhancement, and areas having natural and landscaped value, in need of protection and maintenance.

Two key locations have been identified within or in close proximity to the project footprint. These are described here.

- The Ellenbrook City Centre near the northern terminus of the route has passive and active recreation values, as well as being a focus for local community activity.
- The main eastern entrance to Whiteman Park is notable for its natural beauty, conservation significance and high visibility for motorists travelling along Lord Street.

Other areas of note include land zoned special use or residential development which abuts extensive sections of the project footprint, as well as the Ellenbrook Christian College.

Much of the recent residential development in Brabham orients away from Lord Street such that rear yards back onto existing and proposed sandstone estate feature walls. The majority of dwellings fronting Fairmont Boulevard are the exception and orient westwards towards the project footprint.

2.3.10.3 Assessment of potential impacts to visual amenity

Clearing of mature native vegetation and alterations to the built form, as a result of the proposal may result in impacts to local visual amenity and give rise to public sensitivity. In turn, this may result in perception of impact to property values in proximity to new built structures, such as bus stations.

2.3.10.4 Proposed management measures for visual amenity

The objective for managing the potential visual impacts of the proposal are to minimise adverse impacts to visual amenity. A range of management measures are recommended to minimise impact and improve amenity for road users and nearby residents.

The proposed addition of bus stations is likely to alter the visual landscape of the project footprint; however, the impact can be minimised through blending; however, it is not considered feasible to completely screen the bus stations from public view. Best practice siting and design of the stations and associated infrastructure will reduce the necessity for blending or screening initiatives.

It should be noted that adherence with designing out crime guidelines (provision of adequate lighting and sight lines for surveillance), the requirement for legibility (directional signage and clearly defined entry points), as well as unobstructed paths of travel is not conducive with screening being provided within the immediate vicinity of the stations themselves.

To preserve the amenity in the vicinity of the Ellenbrook station, continuity of vistas and pedestrian linkages is encouraged, where practicable. To achieve continuity of vistas, dense landscaping or solid walls should be avoided. It is noted that existing vegetation is predominantly pine trees that have little bulk.

It is acknowledged that much of the study area is reserved for public purpose – special use under the Metropolitan Regional Scheme including land currently utilised for recreational purposes by the Ellenbrook Christian College. The study area is additionally zoned or immediately abuts land zoned special use, general rural or residential development under the City of Swan local planning scheme. Landscaping and enhancement techniques in conjunction with siting and design considerations should be sufficient to soften visual impact and improve visual amenity. Landscaping and enhancement techniques will reduce perceptions of noise impacts and, in some specific locations may provide limited noise attenuation value.

Feature walls may be considered to mitigate noise and offset perceptions of loss of land value in some locations. There are four locations for which feature walls and accompanying enhancement may be considered:

- North of San Lorenzo Boulevard between Vauclause Crescent and Messina Grove in Ellenbrook.
- Adjacent to the Ellenbrook Christian College extending south behind dwellings fronting Vallinco Avenue and Ponte Vecchio Boulevard in Ellenbrook.
- Extending from north of Park Street predominantly west of Fairmont Boulevard in Brabham.
- East of Rugby Street extending south of Granleigh Street to Marshall Road in Bennett Springs.

The use of landscaping forward of any walls will soften the lines and potentially mitigate the risk of graffiti. Restoration and rehabilitation of existing vegetation will also serve to improve the amenity and assist in activating nearby space.

Should feature walls replace existing boundary fencing, not only will noise impacts be mitigated, but the capital improvement may serve to off-set perceptions of loss of land value.

Photographic images of visual amenity within or near to the project footprint are included in Appendix H.

2.4 Commonwealth aspects and impacts

A Level 1 biological survey conducted in October 2015 (AECOM 2016) identified two Matters of National Environmental Significance (MNES) as occurring within the project footprint including Rainbow Bee-eater (*Merops ornatus*) and Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksia naso*). Indirect evidence of two further species, Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) and Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) was also observed.

A search of the Australian Government Department of the Environment (DoE) Protected Matters Database of the project footprint, with a 10km buffer, was conducted on 15 February 2015. This search identified 18 bird species, 12 migratory bird species, two mammals and 21 plant species as potentially occurring within the search area.

The search also identified a number of marine species as potentially occurring. As the project is strictly terrestrial, and there is no marine habitat within the project footprint, these species are not considered further. The full EPBC Protected Matters Search Report is provided at Appendix I.

Finally, the search identified seven listed Threatened Ecological Communities as potentially occurring within the search area.

2.4.1 Likelihood of occurrence

Table 41 provides an assessment of the likelihood of occurrence of MNES within the project footprint, based on information regarding each species or TEC's known distribution and preferred habitat requirements, as defined in the Species Profile and Threats Database (DoE 2016f) or as otherwise referenced. On this basis, two species are recorded in the project footprint, two are considered likely to occur and five species may occur within the project footprint. The remaining species are considered unlikely to occur.

None of the seven identified TECs are considered likely to occur within the project footprint.

The list of MNES included in Table 41 is a compilation of species identified by the Protected Matters Search report and the Level 1 assessment conducted by AECOM (2016).

Table 41 Assessment of likelihood of occurrence of MNES within the project footprint

Species	Conservation status	Assessment of likelihood of occurrence
Birds		
Anous tenuirostris melanops Australian Lesser Noddy	Vulnerable	Unlikely to occur. This species occurs predominantly at the Houtman Abrolhos islands, Western Australia, which occurs outside of the project footprint.
Calyptorhynchus banksia naso Forest Red-tailed Black Cockatoo	Vulnerable	Recorded. This species generally occurs in Jarrah, karri and Marri forests receiving more than 600mm of average annual rainfall; but also occurs in other forest and woodland types where Marri and Jarrah occur. Other food sources include Blackbutt, Albany BlackButt, Forest Sheoak, Snottygobble and non-native species, o Spotted Gum and Cape Lilac. Since 1995, the population has extended into the Swan Coastal Plain in search of food.
Calyptorhynchus baudinii Baudin's Black Cockatoo	Vulnerable	May occur. This species breeds in the south-west of Western Australia in Jarrah, Karri and Marri forests receiving more than average annual rainfall of 750mm; however during the non-breeding season, its distribution is determined by the presence of marri, which is its primary food source. The species also feeds on Jarrah, Western Sheoak, Banksia species, hakea species, Grass Tree, and non-natives including Radiata Pine, fruits such as Apple, Pear, Jacaranda and Pecan. Given the availability of Marri within the project footprint, it is likely that this species occurs during the non-breeding season to forage.
Calyptorhynchus latirostris Carnaby's Black Cockatoo	Endangered	Likely to occur. This species in the south-west of Western Australia. It breeds predominantly in the wheatbelt in areas receiving between 300mm and 750mm of average annual rainfall but also occurs on the Swan Coastal Plain and the southern Swan Coastal plain. The species forages in remnant native vegetation utilising proteaceous shrubs, which occur on sandplains that surround woodlands. It also feeds on Marri and non-native pine plantation. Given the project footprint is within the known distribution of Carnaby's Black Cockatoo and the project footprint supports suitable foraging species and potential habitat trees, it is likely that this species occurs within the project footprint.
Leipoa ocellata Malleefowl	Vulnerable	Unlikely to occur. This species inhabits semi-arid regions of southern Australia in shrubland and low woodlands dominated by mallee vegetation. In Western Australia, it occurs south and west of a line from Cape Farquhar, north of Carnarvon to Eyre Bird observatory in the south east of Western Australia. Suitable habitat for this species does not

Species	Conservation status	Assessment of likelihood of occurrence
		occur within the project footprint and it was not recorded during the field survey (AECOM 2016).
Rostratula australis Australian Painted Snipe	Endangered	Unlikely occur. This species is most common in Eastern Australia where it inhabits freshwater wetlands, swamps and claypans. This species was not recorded during the field survey (AECOM 2016).
Migratory Birds		
Apus pacificus Fork-tailed Swift	Migratory	May occur. This common and widespread species occurs from Augusta to Carnarvon in coastal and sub-coastal areas, in association with a wide range of habitats including riparian woodland, low scrub, sandplains, farmland and usually in association with water. Suitable habit is present within the project footprint.
Merops ornatus Rainbow Bee-eater	Migratory	Recorded. This species was found during the field survey in October 2015 (AECOM 2016). The presence of sandy substrate in proximity to water, provides suitable habitat for this species.
Motacilla cinerea Grey Wagtail	Migratory	Unlikely to occur. This species is considered an extremely uncommon migrant to Australia, with only two sightings in Western Australia, both on the south coast.
Haliaeetus leucogaster White Bellied Sea Eagle	Migratory	Unlikely to occur. This species occurs around the coastline of mainland Australia and Tasmania, and extends inland along larger waterways, especially in eastern Australia. Given the distance of the project from the coastline and lack of large waterways, suitable habitat is not present within the project footprint to support this species.
Plegadis falcinellus Glossy Ibis	Migratory	Unlikely to occur. This species generally occurs east of the Kimberley in Western Australia and at the Eyre Peninsula in South Australia, with only patchy distribution elsewhere in Western Australia. The project footprint is outside of the known distribution of this species.
Migratory Wetland Birds		
Ardea alba Great Egret	Migratory	May occur. This species occurs is widespread in Australia and is known to breed in the south-west of Western Australia. It occurs in a wide range of wetland habitats. Suitable habitat may occur within the project footprint.
Ardea ibis Cattle Egret	Migratory	May occur. This species occurs is widespread in Australia and non-breeding populations are known to occur in south-west Western Australia in grasslands, woodlands and wetlands. Suitable habitat may occur within the project footprint. This species was not recorded during the field survey.

Species	Conservation status	Assessment of likelihood of occurrence
Pandion haliaetus Osprey	Migratory	Unlikely to occur. The distribution of this species is widespread and occurs in littoral and coastal habitats and wetlands.
Tringa nebularia Common Greenshank	Migratory	Unlikely to occur. This species is a non-breeding visitor to Australia, occurring in all types of wetlands in coastal and estuarine habitats. In Western Australia it is found from Cape Arid in the south to Carnarvon in the north-west. .
Mammals		
Bettongia penicillata Woylie	Endangered	Unlikely to occur. Scattered populations of this species occur throughout Jarrah forest in the south-west of Western Australia. Preferred habitats include forest to grassland, coastal and inland where there is dense undergrowth which provides shelter. This species has been recorded in Whiteman Park. Given the highly degraded condition of vegetation within the project footprint, it is unlikely that suitable habitat exists to support this species. This species was not recorded during the field survey (AECOM 2016).
Dasyurus geoffroii Chuditch, Western Quoll	Vulnerable	Unlikely to occur. This species occurs predominantly in contiguous Jarrah forest of the south west of Western Australia, but it also occurs in other Eucalypt forest, dry woodland and mallee shrublands. Some records exist from the Gnangara pine forest and Walyunga National Park. As the preferred habitat for the Chuditch is not present within the project footprint, it is unlikely to occur. This species was not recorded during the field survey.
Pseudocheirus occidentalis Western Ringtail Possum	Vulnerable	Unlikely to occur. This species occurs in association with peppermint Trees near swamps, watercourse or floodplains. The current distribution occurs predominantly two areas, near Bunbury to Leeuwin-Naturaliste National Park and near Albany. Isolated records occur from areas with mature stands of Peppermint Tree. The project footprint is outside of the known distribution of current populations and does not include suitable habitat for this species.
Reptiles		
Pseudemydrua umbrina Western Swamp Tortoise	Critically Endangered	Unlikely to occur. This species occurs in one viable population at Ellen Brook Nature Reserve. Two further populations at Twin Swamps Nature Reserve and Mogumber Nature Reserve are maintained with translocated captive born individuals. All of these populations occur outside of the project footprint.

Species	Conservation status	Assessment of likelihood of occurrence
Plants		
Acacia anomala Grass Wattle	Vulnerable	Unlikely to occur. This species grows on the western slopes of the Darling Range east of Perth, from Chittering South to Pickering Brook, in shallow sand, loam, clay or gravel that is brown, yellow or grey. This species was not recorded during the field survey (AECOM 2016).
Andersonia gracilis Slender Andersonia	Endangered	Unlikely to occur. This species is known from three locations including Badgingarra, Dandaragan and Kwinana where it is found on seasonally damp, black sandy clay flats on or near swamp margins (DEC 2006). The project footprint it outside of the known distribution and does not include suitable habitat for this species.
Anigozanthus viridis subsp. *Terraspectans* Dwarf Green Kangaroo Paw	Vulnerable	Unlikely to occur. This species is known from six populations west of Cataby, which is approximately 120km north of the project location.
Caladenia huegelii King Spider-orchid	Endangered	Unlikely to occur. This species occurs within 20km of the coast on the Swan Coastal Plain in mixed jarrah/Banksia woodland (DEC 2009). The project footprint lies on the boundary of the known distribution of this species, is predominantly cleared or disturbed, with the majority of remnant Marri/Melaleuca woodland.
Calytrix breviseta subsp. *Breviseta* Swamp Starflower	Endangered	Unlikely to occur. This species is confined to the Kenwick area where it occurs on low lying, sandy clay flats among low heath over low sedges (CALM 2004). The project footprint is outside of the known distribution of this species and does not contain suitable habitat.
Chamelaucium sp. Gingin Gingin Wax	Endangered	Unlikely to occur. This species is confined to the Gingin/Chittering area in a range of approximately 3km. This is well outside of the project footprint.
Conospernum undulatum Waxy-leaved Smokebush	Vulnerable	Unlikely to occur. This species only occurs in an area between the suburbs of High Wycombe and Martin, in the foothills of the Darling Scarp, which is well outside of the project footprint.
Darwinia foetida Muchea Bell	Critically Endangered	Unlikely to occur. This species occurs in three locations near the town of Muchea, which is approximately more than 20km from the project location.
Diuris purdiei Purdie's Donkey-orchid	Endangered	Unlikely to occur. This species grows on sand to sandy clay soils in areas subject to winter inundation, from Perth south to the Whicher Range. The project footprint is outside of the distribution of this species and the Bassendean Sands which cover the majority of the project footprint are unlikely to support this species.

Species	Conservation status	Assessment of likelihood of occurrence
Drakaea elastica Glossy-leafed Hammer-orchid	Endangered	Unlikely to occur. This species occurs on bare patches of white sand over dark sandy loam on low-lying damp areas, in association with Banksia and Marri. This habitat is not available within the project footprint. The Glossy-leafed Hammer-orchid was not recorded during the field survey. It should be noted that this species does not necessarily flower every year, making detection difficult.
Drakaea micrantha Dwarf Hammer-orchid	Vulnerable	Unlikely to occur. The Dwarf Hammer-orchid is usually found on cleared firebreaks or open sandy patches that have been disturbed, in infertile grey sands in association with Jarrah, Common Sheoak or Banksia species. Suitable habitat may occur within the project footprint. This species was not recorded during the field survey (AECOM 2016) and a search of NatureMap did not identify records near the project footprint. It should be noted that this species does not necessarily flower every year, making detection difficult.
Eleocharis keigheryi Keighery's Eleocharis	Vulnerable	Unlikely to occur. This species grows in clumps in clay or sandy loam substrate in association with *Melaleuca glateritia*. Suitable soil substrate does not occur within the project footprint and is therefore unlikely to support this species.
Eucalyptus balanites Cadda Road Mallee	Endangered	Unlikely to occur. This species occurs in only two locations including Badgingarra National Park and from one individual in the city of Armadale. It grows on light sandy soils with much surface laterite. The species was not recorded during the field survey and is not known to occur in the vicinity of the project footprint.
Grevillea curviloba subsp. *Curviloba* Curved-leaf Grevillea	Endangered	Unlikely to occur. This species occurs in a very restricted range, in association with the Muchea Limestone community. Suitable habitat does not occur within the project footprint and the species was not recorded during the field survey.
Grevillea curviloba subsp. *Incurva* Narrow curved-leaf Grevillea	Endangered	Unlikely to occur. This species occurs in an area between Muchea and Badgingarra in open heath in winter-wet sites on sand over limestone or over ironstone at sites with a high water table. The species is not known to occur within the project footprint and was not recorded during the field survey.
Lepidosperma rostratum Beaked Lepidosperma	Endangered	Unlikely to occur. This species grows in peaty sand and clay amongst low heath in winter-wet swamps, in association with Marsh Banksia and Hairy Clawflower. Suitable habitat does not occur within the project footprint and the species was not recorded during the field survey.

Species	Conservation status	Assessment of likelihood of occurrence
Macarthuria keigheryi Keighery's Macarthuria	Endangered	Unlikely to occur. This species is known from one population near Cooljarloo and a further five populations from Welshpool and Kewdale, all of which are outside of the project footprint. This species was not recorded during the field survey.
Thelymitra dedmaniarum Cinnamon Sun Orchid	Endangered	Unlikely to occur. This species occurs on red-brown sandy loam and is known from two populations north-east of Perth near Jumperkine Hill, which is approximately greater than 15km north east of the project footprint. Suitable habitat for this species does not occur within the project footprint and the species was not recorded during the field survey.
Thelymitra stellata Star Sun-orchid	Endangered	Unlikely to occur. This species grows on red, brown, yellow or grey sandy loams or clay or gravel over laterite or gravel, in Jarrah and Wandoo woodland. It occurs from Three Springs in the north to Darkan in the south, with the majority of records from Geraldton Sandplains and the Jarrah Forest in Toodyay, Muchea and Armadale. The species was not recorded during the field survey.
Trithuria occidentalis Swan Hydatella	Endangered	Unlikely to occur. This species is known from one population in the Ellenbrook area where it grows partly submerged on the edge of winter-wet claypans in open shrub of *Melaleuca lateritica*. Suitable habitat does not occur within the project footprint and the species was not recorded during the field survey.

In addition to threatened and migratory flora and fauna species, the Protected Matters Search identified seven Threatened Ecological Communities as potentially occurring within a 10km buffer of the project footprint.

These are identified in Table 42 below.

Table 42 TECs potentially occurring within the project footprint

TEC	Conservation status	Likelihood of occurrence within project footprint
Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain	Endangered	The buffer of this TEC intersects with the northern boundary of the AECOM study area (AECOM 2016). It does not occur within the project footprint.
Claypans of the Swan Coastal Plain	Critically Endangered	This TEC includes clay-based wetlands which rely on rainfall to fill (DSEWPaC 2012b). Most of the project footprint is underlain by sandy soils, with a small portion underlain by lake deposits including mud, clay, silt and sand (AECOM 2016). This TEC is unlikely to occur within the project footprint.
Corymbia calophylla – Kingia australis woodlands on heavy soils of the Swan Coastal Plain	Endangered	This TEC occurs on the wettest soils on sites with high rainfall on the eastern side of the Swan Coastal Plain, located on a layer of impervious clay soil that acts as a barrier to drainage (DoE 2016g). The majority of the project footprint is underlain by sandy soils. This TEC is unlikely to occur within the project footprint.
Corymbia calophylla – Xanthorrhea preissii woodlands and shrublands of the Swan Coastal Plain	Endangered	This TEC occurs on dry soils on sites with low rainfall on the heavy soils of the Swan Coastal Plain (DoE 2016h) and is known from seven locations. All known occurrences of this TEC occur outside of the project footprint (DoE 2016h).
Shrublands and woodlands of the eastern Swan Coastal Plain	Endangered	This TEC occurs on the transitional soils of the Ridge Hill Shelf on the Swan Coastal Plain adjacent to the Darling Scarp, but extends marginally onto the alluvial clay deposits on the eastern fringe of the Swan Coastal Plain (DoE 2016i). The project footprint is outside of the known distribution of this TEC.

TEC	Conservation status	Likelihood of occurrence within project footprint
Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain	Endangered	This TEC is located approximately 1km northeast of the AECOM study area and does not occur within the project footprint (AECOM 2016).
Subtropical and Temperate Coastal Saltmarsh	Endangered	This TEC occurs in a narrow margin of the coastline in areas under regular or intermittent tidal influence (DoE 2013b). The project footprint is approximately 20km inland from the coastline and therefore does not contain this TEC.

None of the identified TECs are considered likely to occur within the project footprint.

2.4.2 Assessment against Referral Guidelines

One species of black cockatoo, Forest Red-tailed Black Cockatoo was recorded in the project footprint during the biological survey conducted in October 2015 (AECOM 2016). Carnaby's Black Cockatoo and Baudin's Black Cockatoo are also considered likely to occur given the presence of suitable foraging habitat.

On this basis, an assessment against the *EPBC Act Referral Guidelines for three threatened black cockatoo species* (DSEWPaC 2012a) has been undertaken in Table 43 below.

Table 43 Assessment against Referral Guidelines

Referral Guideline	Assessment
Clearing of any known nesting tree	No known nesting trees are present within the project footprint. Ground survey identified 106 mature Eucalypts, predominantly Marri, with DBH of 500mm or greater, three (3) of which have hollows. One hollow was occupied by bees at the time of survey.
Clearing or degradation of any part of a vegetation community known to contain breeding habitat	Ground survey identified three trees with DBH of 500mm or greater to have a hollow with an opening of 5cm or greater. One hollow was occupied by bees at the time of survey. The project footprint is within the breeding range of Forest Red-tailed Black Cockatoo and Carnaby's Black Cockatoo but is outside of the breeding range for Baudin's Black Cockatoo.
Clearing of more than 1ha of quality foraging habitat	More than 1ha of quality foraging habitat will be cleared for the project. The project footprint contains 10.0ha of Marri woodland plus a further 106 mature Eucalypts, predominantly Marri, over cleared pasture, which provides foraging habitat for Forest Red-tailed Black Cockatoo.

Referral Guideline	Assessment
	A further 1.2ha of pine plantation provides foraging habitat for Carnaby's Black Cockatoo and Baudin's Black Cockatoo. Forest Red-tailed Black Cockatoo is not known to forage on pine plantation.
Clearing or degradation (including pruning the top canopy) of a known night roosting site	No known night roosting sites will be impacted.
Creating a gap of greater than 4km between patches of black cockatoo habitat (breeding, foraging or roosting)	The project footprint is already predominantly cleared, and is immediately adjacent to Bush Forever Site Whiteman Park and Gnangara-Moore River State Forest. The project will not create a gap of greater than 4km between areas of habitat.

The project will result in clearing of more than 1ha of foraging habitat. While this habitat is considered predominantly degraded to completely degraded, it is within the modelled distribution for the three species and contains mature eucalypts suitable for foraging. The project has a high risk of significant impact to black cockatoos and requires referral to the Australian Government Department of the Environment under the *Environment Protection Biodiversity Conservation Act 1999* (EPBC Act).

2.4.3 Assessment of impacts against Significant Impact Criteria

An assessment of potential impacts to MNES that are recorded, likely to occur or may occur within the project footprint, using the Significant Impact Criteria (DoE 2013a) is provided below in Table 44. This assessment shows that the project is most unlikely to result in any significant impact to MNES.

Table 44 Assessment of Existing Environment, MNES and Likely Impact

Matter of National Environmental Significance	Existing Environment and Likely Impact
Migratory species	
Merops ornatus (Rainbow Bee-eater)	
Is the action likely to:	
a) substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?	No. The Rainbow Bee-eater is widely distributed throughout Australia, Indonesia and Papua New Guinea and occupies a wide range of habitats, showing adaptability to disturbance. It is unlikely that clearing of 10.02ha of potential habitat will destroy or isolate an important habitat for this species.
b) result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?	No. The only known threat to Rainbow Bee-eater is the introduced Cane Toad, which is not currently present in the vicinity of the project footprint.
c) seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically	No. While nests and several pairs of birds were recorded within the project footprint, it is unlikely that it supports an

Matter of National Environmental Significance	Existing Environment and Likely Impact
significant proportion of the population of a migratory species?	ecologically significant proportion of the population of a migratory species.
Apus pacificus (Fork-tailed Swift)	
Is the action likely to:	
a) substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?	No. This species is a non-breeding visitor throughout Australia and its populations are considered stable across most of its range. It is exclusively aerial; therefore, clearing for this project is unlikely to destroy or isolate an area of important habitat for this species.
b) result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?	There are no significant threats to Fork-tailed Swift.
c) seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species?	No. This species is a non-breeding visitor to Australia and therefore the project is unlikely to disrupt the lifecycle of an ecologically significant proportion of the population of the species.
Ardea alba (Great Egret)	
Is the action likely to:	
a) substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?	No. This species is widespread in Australia, occurring in all states and territories. The largest populations occur near the coast in the Northern Territory, south-west Queensland and north-east South Australia. Scattered breeding sites in WA occur in the south-west. While it may occur from time to time in the project footprint, in association with swampland, the project footprint is unlikely to support an area of important habitat for this species.
b) result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?	No. This species is threatened by changes to water flows through water extraction and drainage or clearing of wetlands. A total of 0.02ha of swampland will be cleared for this project. This is not considered to be an area of important habitat for this species.
c) seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species?	No. The project footprint is not known to support breeding of a significant proportion of the population of this species.
Ardea ibis (Cattle Egret)	
Is the action likely to:	

Matter of National Environmental Significance	Existing Environment and Likely Impact
a) substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species?	No. This species is widespread in Australia, occurring in all states and territories. Two key populations occur in north-east Western Australia and the Top End of the Northern Territory; however, non-breeding populations occur scattered in south-west Western Australia. While this species may occur from time to time within the project footprint, the habitat present is unlikely to be an important area of habitat for this species.
b) result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species?	No. This species is threatened by loss of breeding habitat through wetland degradation or clearing. The project footprint is outside of the breeding range for this species. A total of 0.02ha of swampland will be cleared for this project. This is not considered to be an area of important habitat for this species.
c) seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species?	No. The project footprint is not known to support breeding of a significant proportion of the population of this species.
Wetlands of international significance	
No wetlands of international significance occur within the project footprint.	There will be no impact to wetlands of international significance.
World Heritage Properties	
There are no World Heritage Properties within the project footprint.	There will be no impact to World Heritage Properties
National Heritage Places	
There are no National Heritage Places within the project footprint.	There will be no impact to National Heritage Places.
Commonwealth Land or Marine Areas	
There is no Commonwealth land or Marine areas within the project footprint.	There will be no impact to Commonwealth land or Marine areas
Nuclear actions	
Not applicable	
Water resource	
Not applicable	

2.5 Summary of the assessment

The proposal may result in localised lowering of the groundwater table in the vicinity of dewatering activities which may impact vegetation health and water supply in nearby groundwater bores. The scale of such impacts will be minimised via implementation of a Construction Dewatering Management Plan.

Clearing of 21.1ha of remnant native vegetation and the creation of road surface may alter surface and groundwater; however, these potential impacts will be managed through implementation of Water Sensitive Urban Design principles.

There will be no significant impact to flora and vegetation as no priority flora, threatened flora, TECs or PECs occur within the project footprint. Recent design changes to the project footprint mean that 1.5ha of the project footprint has not been surveyed. Most of this unsurveyed area is cleared land and holds little fauna habitat value. It is proposed to survey this area prior to construction.

There will be some loss of foraging habitat for Forest Red-tailed Black Cockatoo as the project will result in the removal of mature Marri and Jarrah trees, its preferred foraging species. No significant impact is predicted to Carnaby's Black Cockatoo as the preferred foraging species are not in abundance within the project footprint and there is only limited breeding habitat. No significant impacts are predicted to Baudin's Black Cockatoo as the project footprint is outside of the modelled distribution for this species.

Impacts to local populations of other conservation significant species including Rainbow Bee-eater, Western Brush Wallaby and Quenda are not expected to be significant as substantial areas of suitable habitat for these species is known to occur in nearby reserves and National Parks.

There is a high likelihood of impact to Aboriginal heritage as the project footprint intersects a number of registered sites.

Ground disturbance and dewatering may result in exposure of ASS, causing soil acidification or mobilisation of heavy metals in groundwater. The potential for this impact to occur will first be determined and subsequently will be managed via the Construction Dewatering Management Plan.

Dust emissions are likely to be temporary, occurring during the construction phase and may result in some loss of amenity; however, these impacts are expected to be short term and will be managed to minimise amenity impact.

The proposal is unlikely to introduce or contribute to the spread of dieback, but for the purposes of management, should be considered to be infested.

An assessment of land tenure identified a number of freehold lots within the project footprint. These properties will be subject to acquisition by MRWA to enable the proposal to proceed.

Clearing and construction has the potential to produce short term noise and vibration impacts on sensitive receptors. In addition the operation of the EBRT has the potential to result in a change in noise sources and volumes. A Construction Noise and Vibration Management Plan will be developed to minimise the scale of impacts during the construction phase.

Minimal adverse impact to visual amenity is predicted and there will be no adverse impact to conservation areas.

A range of management measures are identified to manage impacts. These are described in the report and are summarised in Appendix A.

2.6 Recommendations for further assessment

Prior to commencement of construction, the following additional assessments are recommended.

- Conduct biological survey of 1.5ha of previously unsurveyed footprint.

- Fauna specialist to inspect footprint to ensure no active black-cockatoo nests, and no active Rainbow Bee-eater nests
- Baseline traffic survey and noise modelling to be undertaken to predict noise impacts to nearby sensitive receptors
- Consult with DER to assess likely extent of groundwater contamination beneath the project footprint and potential impacts of dewatering on groundwater quality
- Detailed ASS investigation of high risk areas within the project footprint

2.7 Consultation and liaison

Main Roads will consult with the local and state government and the local community in relation to land acquisition and potential impacts that may arise from the project.

2.8 Environmental management

An EMP has been developed for the project which identifies project components, management actions, monitoring, responsible persons and completion timeframes. This is provided in Appendix A.

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